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An Illustrated Weekly Journal

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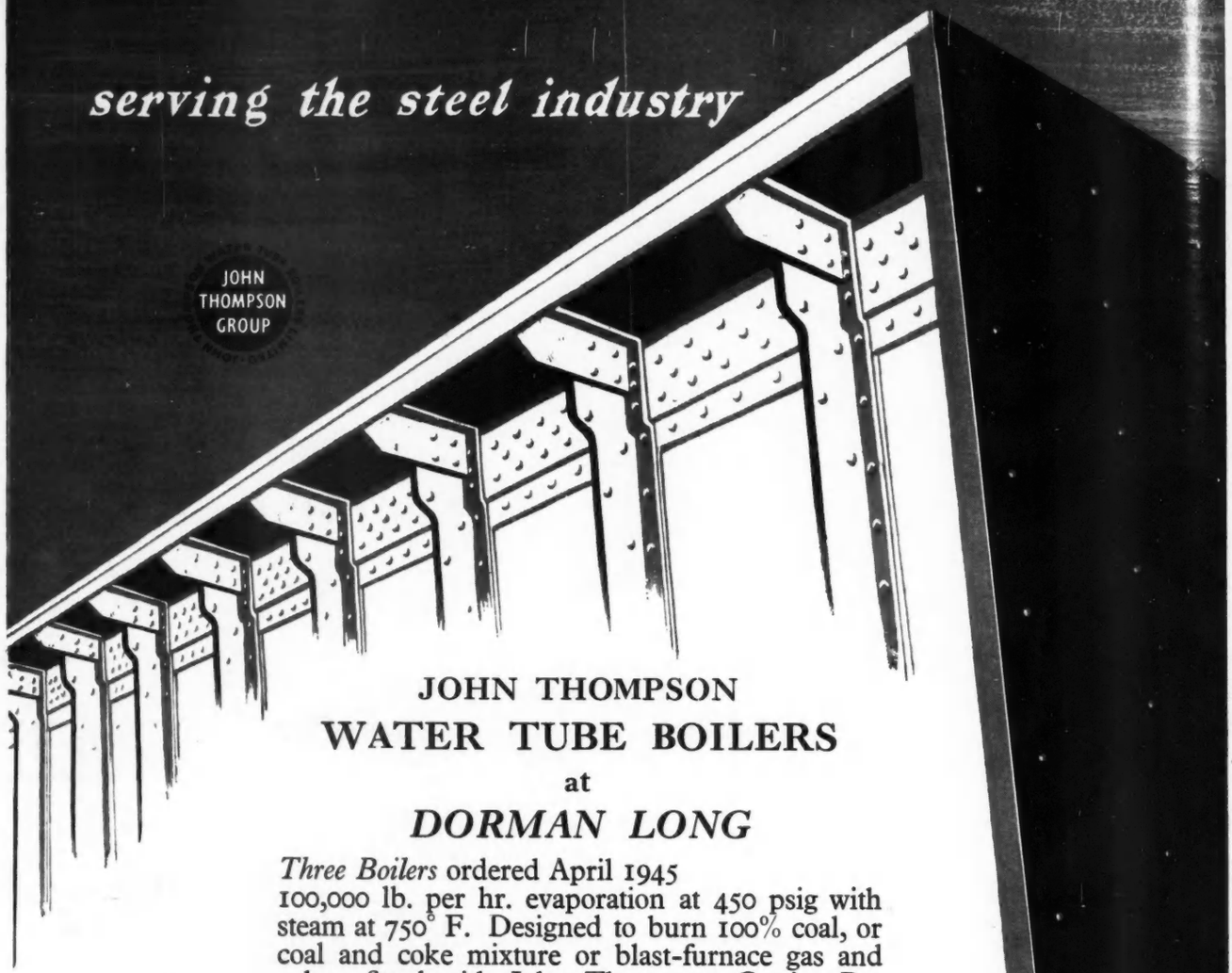

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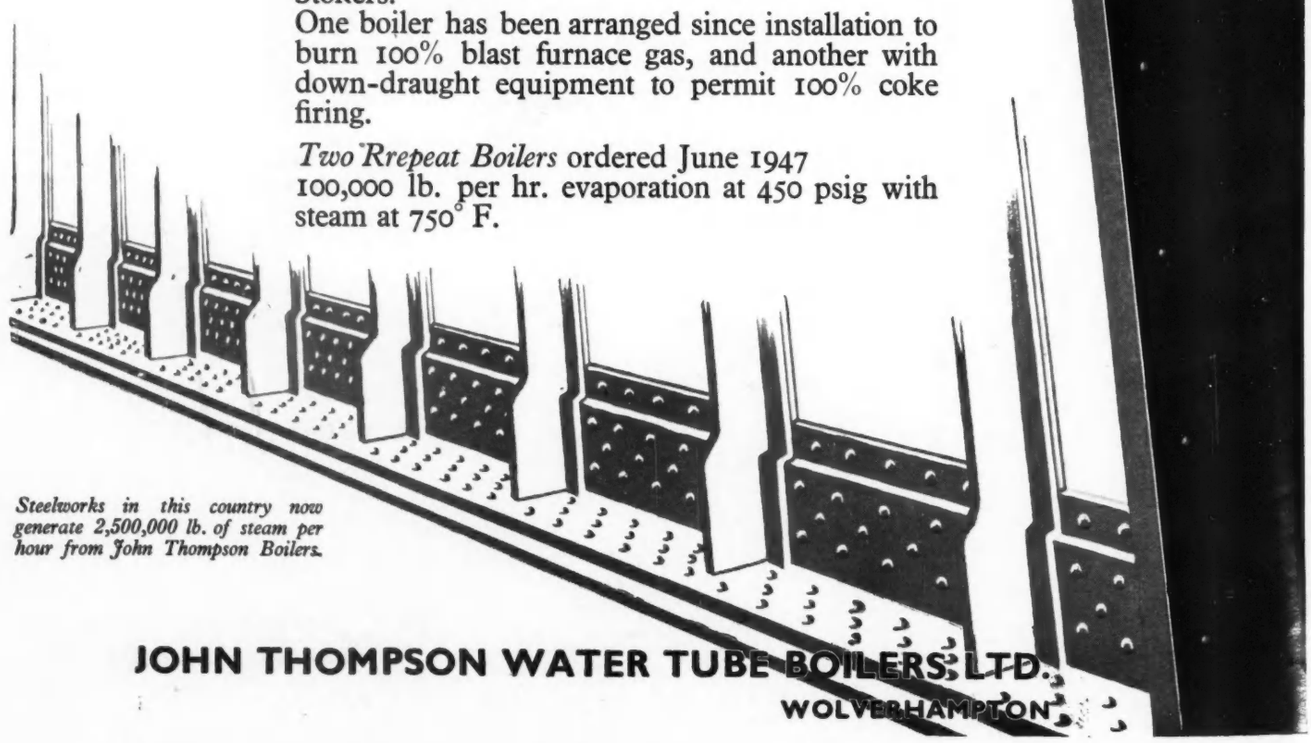

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ENGINEERING

An Illustrated Weekly Journal

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CELEBRATE A CENTURY

WITH this issue, ENGINEERING completes 90 years of publication. It is a fact worth recording but not worth special celebration. For one thing, a journal of 90 is not like a man of the same age: the journal must constantly look to the future, secure in its firm foundation, whereas the man can only reflect on the past. For another, 90 is so near to 100 that we must clearly wait another ten years before we put the flags out and celebrate the slightly bogus magic of a century (the binary system of electronic computers has been a reminder of the fact that the choice of the decimal system of counting is quite arbitrary).

Bogus or not, a century of publication is undoubtedly something to be proud of, and we rejoice that our contemporary *The Engineer* has attained to this distinction. We have travelled almost the same path since ENGINEERING was started in 1866. At first the rivalry obtruded in the editorial columns of both papers, to the extent of quite vindictive remarks on each other's competence, if not, indeed, parentage. But in time this element disappeared and both journals concentrated their whole attentions on their prime function—to serve their readers. *The Engineer* has a fine record of service. May their second century be as great.

At 90, however, we must look forward, not only for ourselves but—more important—for the individual engineer. What are his prospects in the coming year? What kind of work will he be engaged on? There are as many answers as there are engineers, but there are some common threads of experience which can be picked out and examined as 1955 draws to a close. The most personal question is whether the individual is fully employed. Whether he is using, or is being allowed to use, his experience and abilities to the fullest extent. For it does not follow that in times of full employment everyone is fully employed. While some industries are having great difficulty in recruiting all the men they need, others are holding on to staff who can only be kept occupied by creating work. The sham may pass completely unnoticed even by those involved; there be every outward appearance of prosperity; but the useful and profitable output—usually difficult to measure—will be small in relation to the size of staff employed. Lord Reith, who started his career as an engineer, has given a vivid record, in his remarkable autobiography, of both extremes of employment—the full life he led when he was laying the foundations of the B.B.C.; and another time (war-time, when everyone seemed to be fully employed) when he chafed under forced partial-employment. There should never be a time when anyone with ability and the will to work is denied the opportunity. During the coming year, therefore, it may be possible to eradicate those cases of wasted effort that are masked by current full employment.

The engineering industry increased its total labour force last year. But its increase in output was even greater. Engineering is the main-stay of the country, whether we consider only those industries which can properly be classified in this way or whether we include—as we should—the work of engineers in non-engineering industries. For it is these engineers who have the hardest task, and can often point the way to the most valuable results. It is natural, when reviewing the history of engineering, to select the major works—bridges, dams, locomotives, power stations and the like—as the landmarks of progress. But in practice relatively few engineers are engaged on these works. Far more find an outlet for their talents in work which happens not to be spectacular or in the public eye. Often, too, they are the engineers who receive least help from professional bodies or technical journals. Everything they do is their own work. Some day, perhaps, such an engineer will write his autobiography as Lord Reith has done.

Though British engineers have succeeded in increasing the debt owed to them by their native country, it is a matter for regret that they have not managed to recapture the pioneering spirit which took many of them overseas in the Nineteenth Century. It is true that the economy of the country as a whole may be best served by remaining in these islands and exporting the products of advanced technology. It is true that some very large contracts abroad still go to British firms, and that our experience is placed freely at the disposal of undeveloped countries through the agency of international bodies. But the Commonwealth countries need all the help we can give them, and there are other States whose urge to industrialise we, of all nations, should be able to satisfy. Empire-building is not the motive: the need is to achieve a balance in the development of these countries and a balance among the major Powers which participate.

This theme may seem so broad as to be irrelevant to the personal questions posed earlier. In fact, they are directly related, for the part played by Britain in world developments will depend very largely on the personal decisions taken by individual engineers. If more and more are attracted by the broader horizon then the peoples of the world will be better served. We can think of no better note on which to end the year 1955, our 180th volume and our 90th year of publication.

Weekly Survey

Cover Picture : *British modern all-weather and night fighter aircraft carry extensive electronic equipment and are heavily armed. To relieve the pilot of the strain of radar operation a second crew member is carried. This technique was first used by the R.A.F. during the war. Results obtained then, and subsequently with jet-propelled night fighters in full-scale air exercises, have confirmed the R.A.F.'s confidence in this technique rather than in the American method of single-seat all-weather fighters. The aircraft shown in the illustration are Meteor NF*14.

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Hint from Machine Tools?

When the total value of the British machine tool industry's output for 1955 is known it will almost certainly prove to be a record. Higher prices have, of course, played a part in this welcome achievement, but there is every indication that tonnage, too, will prove to have been much higher than in 1954, and not far short of the 1953 record figure. Exports are likely to have been rather better than last year but not outstandingly higher.

It will be recalled that the 1954 Budget investment allowances stimulated the demand for machine tools, which built up into an outstanding figure in the first half of 1955. If ever it was true that the industry has been so preoccupied in meeting the demand for certain kinds of machine tools in which it has an established reputation that it had not either resources or opportunity to develop new ideas or extend the range of its products, that time was the first half of this year. Output of metal-working machine tools for the home market increased by 15 per cent. in that period over the corresponding six months of 1954. By mid-year, machine tool orders on hand were 32 per cent. higher than at June, 1954.

Since machine tools led the crest of the boom, will they lead a fall in production ? There is some evidence to show that if the deflationary policy of the autumn is succeeding, it is showing itself first in that industry, so far as capital goods are concerned. In September home orders for machine tools fell by over £1 million. This was the sharpest change in demand in the first nine months of the year. In contrast, the rate of deliveries and production both showed little change from the seasonal pattern. Orders stood at £95·2 million at the end of September, which was 30 per cent. above the level reached at the same time in 1954 and the small decline in production in the third quarter was probably seasonal. Nevertheless this drop of 17 per cent. in home demand is contrary to the usual seasonal trend and may well reflect a cut-back in orders.

For the time being the industry is not likely to be embarrassed by a decline in new orders, for present orders represent about 15 months' production at the 1955 rate. Apart altogether from the possibility that the machine tool industry is acting as a bell-wether for the rest of the engineering industry, a decline in pressure of business after a bout of expanding prosperity might well give manufacturers a breathing space. The pressure of competition abroad, somewhat smaller order books and strengthened financial reserves might provide a stimulating background for the industry's machine tool exhibition in 1956. The in-coming year might well be chosen as a unique opportunity for the industry to show its prosperity, its originality and its versatility on an unprecedented scale.

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Industrial Production

It has been apparent for some time that the rate of industrial growth in this country is slowing down. In the first nine months of 1955, output of all industries was 5 per cent. up on the corresponding period of 1954, compared with the previous year's rise of 8·3 per cent. in the same period.

Examination of seasonal movements suggests that the rail and dock strikes marked the beginning (and may well have been the major cause) of the slowing down in the rate of growth. The official figures are certainly revealing. In the first half of 1954, production was 7·5 per cent. above the corresponding period of 1953. This increase had slowed to 6 per cent. by the first half of 1955, but the trend became much more marked in the third quarter, when industrial production was only 3·5 per cent. above the same three-monthly period of 1954, compared with an increase of 6·1 per cent. registered in the third quarter of 1954 over the comparable period of 1953. What is significant about this trend is that it became marked (in the third quarter of 1955) after the dock and rail strikes, while only the early stages of the credit squeeze were in operation and before the October budget. This suggests that monetary and fiscal control has merely accentuated a trend which had already set in.

What is important about the credit squeeze is that it has reacted sharply upon demand, which up to October was running far ahead of output and forcing prices and costs up. To a certain extent, demand, particularly for consumer durables such as domestic appliances and radio and television sets, has been brought more into line with output, and sales of such goods have declined since October. On the side of investment the credit squeeze is unlikely to have any serious effect until present orders are fulfilled. For example, although there has been a reduction in new orders for machine tools, order books assure full output up to fifteen months ahead. As yet, therefore, there is little brake on investment, and what brake there is may serve to help the most important aim of the autumn budget—the encouragement of exports by reducing delivery dates and forcing British manufacturers to sell more abroad as it becomes more and more difficult to sell at home. As yet, there is little reason for complacency about Britain's trade gap. While exports in November at £262 million brought the eleven months' figure to 9¼ per cent. higher than a year earlier, imports at £342 million brought the eleven months' figure to 16 per cent. higher. In the third quarter of 1955, the trade gap averaged £74 million a month, and any hope that the credit squeeze would have any immediate effect upon this deficit in October, when the gap was reduced to £53 million, was dashed when the deficit climbed to £70 million in November. In December, the strain on the gold and dollar reserves have become even more serious, for the instalments on the gold and dollar loan became due.

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A Record—but not Enough

The year 1955 is closing with a clamour for increased sheet steel and tinplate supplies. It is estimated that by 1958 the output of tinplate will be 1,450,000 tons per annum, which is 66 per cent. above the 1955 level. Much has been heard, too, in the last few months of the struggle to persuade the steel industry to increase its sheet and strip capacity (ENGINEERING, December 2, page 746).

In spite of the dissatisfaction of some of the main steel users about the rate of expansion of the steel industry, it is to be recorded that crude steel production in November achieved an annual rate of 21 million tons—a record figure. It was to be expected that November would be a good month for it is usually the best in the year. Nevertheless, the output of pig iron and steel has exceeded expectation. Much of the public's attention on the iron and steel expansion programme has been concentrated in recent months on the growing blast-furnace capacity. This is natural, since the second post war development programme has emphasised the importance of building up pig-iron capacity. Last month was something of a landmark in this respect for the second 27 ft. diameter blast furnace at John Summers works at Shotton was blown-in. In spite of this activity in pig iron, it has to be recorded that the increase of steel output in November over November, 1954, was 8·5 per cent., compared with an increase in pig-iron output of 7·6 per cent. over the same period.

The year thus ends with a familiar picture. Steel capacity is expanding but not quickly enough; imports of finished steel remain high; yet all the while production records are repeatedly broken. The outlook is for continued serious shortages in certain directions. In addition to the continued pressure from motor-vehicle manufacturers and canning concerns, re-rollers are beginning to experience a shortage of semi-finished steel and, very soon now, the demand for steel plates will start to build up as the ship-building boom gathers momentum.

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Safe Braking

Road safety is a subject greatly to the fore these days and this gives added interest to a paper dealing with the development of the disc brake as applied to road vehicles, a summary of which appears elsewhere in this issue. Of the great claims put forward, one is that fading is almost non-existent with the disc brake, and another is is that it will stand up well to very hard use or abuse. It is for the latter reason that it has been incorporated in aircraft and also to many racing cars. Disc brakes are not new—Dr. Lanchester took out a patent in 1902—but it is only of recent years that their use has been at all extensive. Apart from road vehicles they have been used on railways, aircraft landing wheels (as already mentioned) and are under consideration for colliery winding gear. Although many problems await investigation—in particular protection from dust and grit with the subsequent cooling problem—yet the future seems to offer considerable promise.

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Machinen—not Machines

Austria regained her independence on October 25, and set about celebrating the event with a gala performance of *Fidelio*. Perhaps it is because Austria is known mainly for its music that Britain tends to ignore it as a possible market for manufactured products. Yet a mission from the Federation of British Industries which visited the country at the end of October left convinced that there was a market, that it was growing, and that it would be a valuable asset to British export earnings if manufacturers in this country set about it the right way.

The report of the mission was recently published, and the main contention appears to be that Austrians know too little about British goods, but would welcome further information. This is a very similar state of affairs to the position in the Canadian market described in last week's Survey. In fact just as the United States is Canada's main supplier by virtue of her proximity, so is Germany in the same relationship to Austria. Traditionally Germany has always been Austria's main supplier of manufactured products, and this fact must be accepted. What the F.B.I. mission found so disturbing, however, was that in 1954, not only did Germany increase her exports to Austria by 69 per cent. over the previous year, but Switzerland and Italy were not far behind. Britain's share rose, on the other hand, by a comparatively meagre 16 per cent. Yet Austria's post-war recovery has been rapid and trade liberalisation has made considerable progress. It has just been announced that the Austrian Government will not continue the Foreign Trade Control Act in 1956, implying an even greater measure of trade liberalisation. The recent report suggested that while Austria is a small country and has many thriving industries of its own, the mission was " convinced that British exports to Austria could be modestly but steadily increased over a wide field." The mission investigated several major industries and

concluded that excellent markets existed for locomotive component parts, atomic power plant, chemical plant, machine tools, and to a lesser degree for construction equipment and refinery and pipeline equipment for the expanding oil industry. The market for textile machinery, however, was slight, as Austria is apparently sharing the current European trend of long-term decline in textiles.

The Austrian market is expanding, but British manufacturers must compete favourably both in price and delivery dates with German producers. The usual solutions are advocated by the mission, ranging from direct and expert representation to the possible establishment of assembly plants in Austria and adequate after-sales service aided by a plentiful supply of spare parts. The task would be easier if Austrians knew more about British products and they would learn quicker in their own language. Catalogues describing ranges of British goods would be welcomed by Austrian industrialists, but brochures must describe "machinen" and not "machines."

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Component Manufacturers' Dilemma

In the last month, two of the largest manufacturers of motor-car components have held their annual meetings and in each case concern has been expressed at the pressure of rising costs on expanding output—a pressure which has resulted in reduced profit margins. In the issue of December 23, this problem for Joseph Lucas (Industries), Limited, was discussed. Since then S. Smith and Sons (England), Limited, have published their annual report. It is highly significant that two companies of this size in such a unique position in relation to the motor-car industry should be faced with the same problem of lower profit margins.

S. Smith and Sons point out in their annual statement that group profits were reduced by 8 per cent., due mainly to rising wages and the prices of raw materials. Over the last five years the company has invested £3·5 million in plant and machinery, all of which has been forthcoming out of group income, apart from £917,000 raised by share capital in 1951. Expansion has been necessitated mainly by the continued expansion of the motor vehicle industry to which the company sells most of its output. In fact, the 13 per cent. increase in turnover this year is attributable mainly to the motor trade and expansion on this scale is expected to continue. It is therefore understandable that the company is concerned about its prospects being geared so highly to the expansion of the motor vehicle industry, an expansion which in turn requires an increase in its own capacity which has to be financed at least in part from accumulated profits. It is clear that the company is making every effort to diversify its activities. Sales of clocks, watches and switch and timing devices for domestic and electric appliances have been at a record level over the last year. Another interesting example of diversification has been the contract to supply combustion heaters to railway carriages in connection with the new Diesel locomotive programme of British Railways.

The chairman, Mr. Gordon Smith, also alluded in his statement to the contraction in the aviation division. Here, once again, is an example of the tendency of restricted output of aircraft to increase the dependence of components manufacturers on the motor-car industry. As with so many other companies, the chairman reported increased competition in overseas markets. He declared that further increases in costs in this field must be offset by higher productivity. So far as direct exports of motor components are concerned, he said that the company's profit margin "follows the same declining pattern, and frankly we see little prospect for the immediate future in this direction." There are thus increasing signs that even the large components manufacturers are caught up in the dilemma of rising turnover and reduced profit margins. Even in the case of the large manufacturers like Lucas and S. Smith and Sons, it is by no means certain that they can find their way out of the dilemma by raising prices. That there will be pressure from costs to raise prices is now a foregone conclusion.

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End of a Venture

The decision of Airwork Limited, to discontinue its all-freight transatlantic air service was announced just before Christmas. Its passing will come as a disappointment to those who are interested in the development of air cargo transport across the North Atlantic.

According to the company, the initial expectations of this route have not been fulfilled owing to the prevailing restrictive conditions which now seem likely to continue. It is quite clear that the company's chagrin at having to stop a service which has been running for nine months and which must have cost a good deal of money to run-in, is partly caused by disapproval of the Government's present policy towards independent air operators. Mr. M. D. N. Wyatt, the chairman of Airwork, pointed out when announcing the end of the service that the company was precluded from carrying mail under the terms of its licence, although British mail is carried in foreign aircraft. Second, Airwork had expected to get a permit for passenger charter flights across the North Atlantic but the U.K. Government had refused to take the necessary action in negotiating for permission for such flights from the U.S. Government. Third, the Customs arrangements for effecting trans-shipment at London Airport were not, in his opinion, as favourable as on the Continent, and, despite pressure, no "free trans-shipment zone" had been established at London Airport.

An undertaking of this kind was bound to be a big risk. While it is true that further assistance from the Government might have helped to spread the company's risk over more than one kind of traffic, it was also necessary for cargo traffic to be forthcoming in reasonable quantity in both directions. While it has probably been possible to develop west-bound traffic from the United Kingdom, it has perhaps been less easy to establish a successful sales organisation in the United States, where competition is fierce and prejudice against a foreign organisation bound to be a further obstacle. The same problems may well have occurred in developing traffic from the Continent to North America.

Hind-sight is always cheap. A great deal of work has to go into the preparation of a scheme of this kind, not the least of it being to obtain a licence from the U.S. Government. It will be easy for outsiders to see why the undertaking has not succeeded just as it is, no doubt, for the company concerned. In prospect, the risk seemed a worthwhile one and its failure is a definite setback to the development of British civil aviation on the trade routes of the world.

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Engineers and Nature Preservation

Engineers concerned with the design and execution of hydro-electric works are familiar with the opposition offered by those who constitute themselves guardians of natural amenities and of agricultural and fishing interests. In Great Britain, this opposition was at one time active in Scotland; it is now more prominent in Wales. There is an international body, the Union Internationale pour la Protection de la Nature, 31 Rue Vautier, Brussels, which concerns itself with the organisation of this opposition. It held its third general assembly at Caracas, in Venezuela, in 1952, and in the course of the meetings a technical session was devoted to the subject of hydro-electricity and nature protection. A summary of this session, reproducing many of the papers read, has been prepared by Lord Hurcomb, and published by the Union.

It is clear that interference with the natural regime may be caused by water-supply and other schemes as much as by hydro-electric works, and this was mentioned in the course of the discussion. None of the papers reproduced is concerned with conditions in this country; they range from America, through Europe to Japan, and it is of interest that in no case is it asserted that overhead transmission lines, necessarily usually associated with hydro-electric works, interfere with natural amenity, although opposition to them, not infrequently fractious, is common in this country. Hydro-electric projects do not loom large in electrical developments in Great Britain and relatively few engineers are concerned with them. Those, however, engaged in work of this kind in Scotland and Wales, and, particularly, consultants dealing with schemes in the Colonies and elsewhere, will find this report interesting and possibly valuable.

The report is necessarily largely concerned with ecological matters, but various criticisms and suggestions bear directly on engineering practice. For instance, while it is admitted that fish ladders are now usually provided, it is considered that too little attention has been given to the preservation of local fish which spawn on bank lines; when water is drawn off and the level falls, the spawn dry off; shallow breeding pools should be provided. It is also asserted that fish life may be imperilled by the construction of major dams on the upper Nile preventing the passage of fish between Lake Victoria and Lake Kioga.

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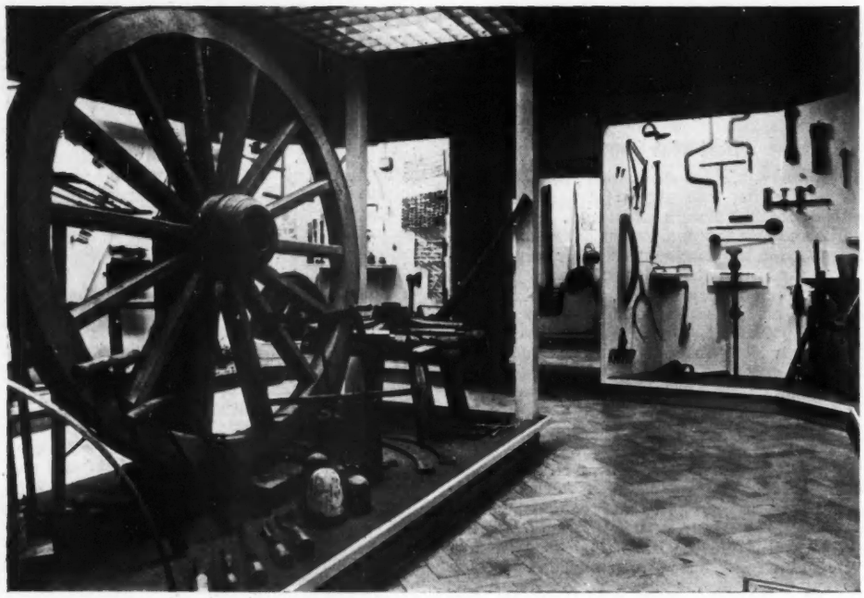
Automatic Train Control

Winter fogs and delays to rail traffic periodically revive public interest in automatic train control. It is natural for the same subject to be linked with accident prevention, often without full appreciation that there is a wide range of costly and destructive accidents against which A.T.C. is no safeguard.

In general, the pre-nationalisation railways preferred to spend their money on improving conventional signalling systems rather than on entirely new devices, although the Great Western installed automatic train control on a large scale, all its main lines being equipped with a system depending for its action on physical contact between a shoe on the locomotive and a ramp between the rails. A month before nationalisation, the L.M.S. Railway completed the equipment of its line between Bow and Shoeburyness with a magnetic inductive system. Unfortunately, factors not associated with signalling caused much criticism of the reliability of London-Southend train services to be levelled at the first line in this country to install an A.T.C. system which conforms with current practice elsewhere by not relying on physical contact for transmitting control effects from track to train.

Since British Railways were formed, practical tests have been carried out over a number of years on the East Coast main line with an A.T.C. system using a magnetic link similar to that of the Southend line installation. The British Transport Commission modernisation plan allocated £100,000,000 for signalling, including A.T.C., and it seems likely that a magnetic link will be retained, although the precise method of applying it is still the subject of some research. Hitherto, there has been a tendency to avoid any system which would involve installing thermionic valves in a locomotive, but the situation has been changed by the development of semi-conductor amplifying devices which are robust and have very small local power requirements compared with the low-tension and high-tension supplies of the ordinary valve.

The arguments against a large investment in A.T.C. will no doubt continue to be heard—especially the recent case of the driver who is believed to have re-set the A.T.C. equipment without realising what he was doing—but with the spread of railway electrification, and perhaps a greater number of fast services operated by multiple-unit trains with only one man in the driving cab, the arguments in favour of A.T.C. may balance the very valid reasons against spending money on it that have so far restricted its use in this country.



A corner of the Museum of English Rural Life, Reading.

TOOLS AND CRAFTS OF THE ENGLISH COUNTRYSIDE

As with civilisation, so with agriculture: practically all stages of development, from the most primitive upwards, are being practised simultaneously in the world to-day. With agriculture, however, until recently it was not necessary to go far afield to find primitive techniques still in operation and largely unchanged through thousands of years. They could be found in these islands.

Only with the last war has the mechanisation of agriculture in England started to push certain traditional tools and methods into complete disuse. It was partly to save them from oblivion that the University of Reading, in 1951, established the Museum of English Rural Life as a national centre for the collection not only of the artifacts of the village but also of information on their use and on the way of life that was their context.

It is not the aim of the museum to include material simply of archeological interest; nor does it include material that is still in common use. Most of the exhibits date from the Eighteenth and Nineteenth Centuries but, owing to the slow rate of change of rural life until recent years, they are largely representative of what has been used since the Middle Ages. The needs of cultivation came second only to those of hunting in the early demands on men's engineering skill, but in the West there has been a long period during which they ceased to profit from this skill as it developed in other fields. The Industrial Revolution was slow in invading the countryside, slower here than in America, where it swept across virgin grassland unopposed by the inertia of tradition.

Consequently the museum was started in time, but only just in time, to rescue many old wagons, ploughs, drills, flails, craft tools and craft products, from woodworm, rust and the scrap-heap. Equally important, the museum has been able to collect information from people still living who can remember how and why these implements were used. Again, only just in time, in the three counties of Berkshire, Oxfordshire and Buckinghamshire there was found only one man who had ever made a farm wagon.

LIGHTWEIGHT CONSTRUCTION

Wagons form an important part of the agricultural collection, and a special study that is being made of their development and regional variation is intended for publication as the first of a series of handbooks. Wandering around a dozen or so of these wagons on a hard standing, one is puzzled by the apparent inconsequence of the variation between types, with their county names, and of the details of design in any one of them. Short of seeing them in use on their native soil (it would probably be safer to say, short of learning to use them), one can only conjecture how they have been shaped by soil and topography, crop and idiosyncracy, and, perhaps, horse and horse-sense. Compare the details of the Sussex wagon with those of the more lightly built Oxfordshire wagon (illustrated on this and the opposite pages): so much in common—the splayed wheels, with their spokes correspondingly dished so that those taking the load are in a vertical plane, and the scalloped corners; yet such a difference, the Oxfordshire wagon sophisticated, its scallops regular and painted, its joints mortised, eager to lose weight and aware, to this end, of the bending-moment distribution in a cantilever!

The ploughs tell a simpler story of adaptation to soil conditions. Most of those in the museum date from the last century. The basic design—coulter, share and mould-board—goes back at least to Saxon times and, of course, has survived mechanisation.

The operation of threshing has a more varied history. Of all the older farm tools, the flail seems least to explain itself. In fact, grain is curiously difficult to separate from the ear, quickly and in quantity, by methods that might seem to be more economical in effort. Most effective is a light rubbing motion, as between the palms of the hands. One of the earliest methods of doing this on any scale involved spreading the corn out on a hard floor and driving either oxon or a threshing sledge round over it; with a substantial layer of corn, this provides the appropriate springy rubbing action, rather than crushing or grinding. Probably earlier still, sheaves of corn would be beaten with a straight stick. Then, it has been suggested, a fortuitous "technological mutation" may have occurred, when a green stick broke in the middle, the two halves being kept together but hinged by the bark; a few more strokes, and the thresher would have decided that this was easier on his back. Hence the flail. In more refined versions, such as are to be seen in the museum, the handle was of ash, the beater often of some heavier wood such as blackthorn, the two being jointed by leather thongs. The first threshing machines unnecessarily simulated the flail action, and it took another two hundred years to develop a machine that would deliver clean grain.

OLD CRAFTS

Agriculture is the core of the museum, as it has been at the core of village life. The next largest section is devoted to crafts: those of the wainwright, the wheelwright, the blacksmith, the saddler and the thatcher, and less familiar ones, such as tile-making—drainage tiles, that is. It is rather interesting that, in the crafts exhibition room, one does not experience as vivid a sense of things past as elsewhere in the museum; this may very well be because many crafts are being kept alive to-day even in—perhaps especially in—large towns, on the hobby level. It is difficult to condition a human being completely out of the pleasure of making, or at least playing at making, something primitive for himself; there is plenty of evidence that the provision of hand-tool kits and appropriate literature for children and their fathers has been found commercially profitable.

In the domestic exhibition room the visitor is decisively back in the past, as might be expected. One wall is taken up by the reconstruction of an open hearth fireplace with relatively-easy chairs and other furniture and utensils. It is a pity this method of display could not have been adopted on a larger scale; this is not to deprecate the excellent layout and lighting of the other displays, but some things look rather unhappy pinned to a wall. Londoners, in particular, will be aware of remarkable improvements over recent years in museum interior design and presentation. The Museum of English Rural

The detail construction of this Oxfordshire wagon of 1838 reveals an intuitive sense of the principles of structures and machines.

A Sussex wagon.

Life, although still short of space, is well up with this trend.

CARD-INDEX RECORD

A brief mention should be made of the records system. Ideas on what form records should take to be most useful, and how they should be kept so as to be accessible to search from a number of possible angles of inquiry, have recently been developing. Unfortunately, too often the soundest ideas defeat application in particular instances because of the difficulty of introducing them retrospectively where there is an accumulation of years of old records. Starting from scratch, the museum staff were able to take full advantage of available experience in developing a records system to meet all foreseeable educational and research requirements. The basis of this is a catalogue card index, of which each card carries a photograph of the exhibit to which it refers, together with whatever information is available on its origin and method of use; it is intended to extend this index to cover appropriate holdings of other museums.

After four years of primary accumulation and research, the Museum was opened to the public earlier this year. From November to April, inclusive, it is open on Wednesday and Saturday afternoons (2.30 to 5 p.m.) only; for the remainder of the year it is open from Tuesday to Saturday (10.30 a.m. to 5 p.m.) and on Sunday afternoons (2.30 to 5 p.m.).

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Letters to the Editor

CASTIGLIANO'S "THEOREM OF COMPATIBILITY"

SIR, Professor Matheson's article (page 828 of your issue of December 16) brings out an unexpected result, that Castigliano's popular "Least Work" theorem can be applied to a class of non-linear structures. The normal method of analysing such structures would be by the Second Theorem of Complementary Energy. Denoting the complementary energy of Professor Matheson's framework by S, and using the notation of his article,

$$e = a\,F^n, \quad (n > 0)$$

$$S = \Sigma \int_0^F e\,dF = \Sigma \frac{a\,F^{n+1}}{n+1} = \Sigma \frac{F\,e}{n+1},$$

where the summation is taken over all the members of the framework.

Conversely,

$$F = a^{-\frac{1}{n}} e^{\frac{1}{n}},$$

$$U = \Sigma \int_0^e F\,de = \Sigma \frac{a^{-\frac{1}{n}} e^{\frac{1}{n}+1}}{\frac{1}{n}+1} = \Sigma \frac{n\,F\,e}{n+1}.$$

The Second Theorem of Complementary Energy asserts that, if X_i represents some redundancy, $\frac{\partial S}{\partial X_i} = 0$; and if n is the same for every member of the framework $U = n\,S$, so that $\frac{\partial U}{\partial X_i} = 0$, which is Professor Matheson's result.

Castigliano's "Theorem of Compatibility" would certainly be a more accurate description than the customary "Least Work," but popular names die hard. A change, if it comes about, will be all to the good; but, undoubtedly, reactionaries will cry that what matters is to understand the physical meaning of the theorem and its use, call it what you will. In truth, Castigliano's theorem has been too attractively nicknamed. Analytical methods entitled "Least Work," "Relaxation," and "Three Moments," are inevitably destined for popular affection.

Yours faithfully,
E. H. BROWN.

Brown University,
Rhode Island,
U.S.A.
December 21, 1955.

CRI DE COEUR

PROBLEMS OF A SOVIET CHIEF DESIGNER

Every engineer has his problems, not least the designer. It may therefore be comforting to learn that many of these troubles are universal. Indeed, in some countries the designer may be faced with difficulties of a kind seldom, if ever, met in Britain, although no doubt we too have problems peculiar to ourselves. The following article is a report of an interview—following an industrial conference—with chief designer L. A. Shubenko, of the Kharkov Turbine Works, which appeared in the Soviet publication "Novy Mir" (*No. 7, page 33, 1955*). *The report is in many ways revealing and a slightly abridged version is given here without comment.*

In summarising the discussion at the industrial conference it is necessary to ask: why is there a gap between the new and growing level of technology and the level of work of the backroom boys and the administrators? In fact, why are the backroom boys dragging along in the rear? The first cause is the narrow scope of designing and research work, and of our experimental shops. The second is the lack of creative friendly competition, and the monopoly position of many groups of designers; and the third is organisational trouble. However hard it is to recognise our faults, we must do so, or everything will stop as it was before.

We live in an age of immense developments in science and technology—the atomic age. Every day we hear of new dramatic achievements in human thought. In this state of affairs the time factor is of paramount importance. If you stop for a single day, you fall behind. What has happened is that our scientific and technical inventiveness has been used up on meeting the most urgent needs of production, and has given little thought to to-morrow; it has been unable to prepare for future technical advance. At first, this lag was imperceptible (it may have been concealed from us by our self-satisfied outlook), but now it has begun to hinder our rapid technological development. Consequently, some of our machines, which used to be as good as the best foreign designs, are now out of date, worse than, say, the American.

NEW CARS

We have all seen on our streets a crowd of gaping bystanders surrounding a foreign car of new design. Sooner or later a voice from the crowd annoys us by saying: "We can't make them like that." Is this remark really justified? Are Soviet designers less talented than those at Ford's or General Motors? I'm sure they are not. We can "make them like that"—and we can do even better. As for gaping bystanders —why call them names?—they are more interested in new technology than the wretched managers of industry who should be producing new models of cars.

Soviet engineers cannot be blamed. Our scientists and designers have often shown in practice their ability to produce the most advanced excavators, aircraft, turbines, and other machinery, not to mention our discoveries in atomic science. The talent of scientists and designers is evidently not at fault.

For instance, we have to use aerodynamic estimates for the rotating parts of a turbine which are 20 years old, and even then they were made abroad. If we were able to experiment, we could easily make fresh estimates and raise the efficiency of our present turbines by at least 5 per cent., which would save the country at least 200 million roubles on fuel per annum. If 10 million of the 200 million roubles we spend every year on warming the earth's atmosphere with our power stations were allocated for research, we should save 190 within a year. But the Ministry of Finance is not in the least interested in making 2,000 per cent. profit.

MONOPOLY AND COMPETITION

The narrow scope of our experimental work also leads to our second fault—the absence of creative friendly competition. The bestial competitive system does not and cannot exist here, but we need to have friendly competition, and we have no one to compete with. We are monopolists in our speciality. The Leningrad Metal Works are monopolists in other turbines. There is no one to criticise us—whatever we do, it is all right. Recently, our Ministry showed some initiative, and ordered three groups of designers to work out the plans for hydro-turbines at a new power station—our designers, and those at the Leningrad and Syzran Turbine Works. The group which produced the best preliminary plans would also prepare the final plans and make the turbine. This was a very good start—the three groups sprang to life, each trying to do better than the others. Friendly competition of this kind must be encouraged in every way.

These are what one might call the large problems of large-scale power production. But the large depends on the small. Here are some small things that we have to put up with. Someone had the bright idea of including designers in the administrative staff. Now administrative staffs are being cut throughout the country, so they have cut down the number of designers, who are the most necessary people in production; and of course they have not cut administrative expenditure on telegrams and unnecessary paper-work, but on pencils and drawing paper.

UNDER-THE-COUNTER METHODS

We have to buy them ourselves. Can you imagine a worker buying a drill in a shop? But this is what designers have to do. I remember last year's epic case of ten sets of Kuhlmann drawing instruments. There is a small factory here in Kharkov which makes them, but it is all arranged so that their director cannot sell

them to us, and our director cannot buy them; So the designer is deprived of the simplest instruments he needs.

To get hold of these ten sets, I had to humiliate myself and be crafty, to use what we call *blat* (under-the-counter methods), to rattle my medals at the regional committee and the director of the other factory. I went from office to office to tie that director down. Finally, he took pity on me; "All right," he said, "I will produce ten sets in excess of the plan and sell them to you." Then I crawled to my own director. "Give me the money for the instruments," I said. A matter of a few thousand roubles would seem unimportant for a works as big as ours, but it turned out that a works director had no power to spend this measly sum without permission from his superiors.

We had to scheme to get it. That great schemer Ostap Bender (the "hero" of Ilf and Petrov's novel of the NEP period, "Diamonds to Sit On") would have envied our cunning. We got the money under the heading "Capital Construction." We bought ten sets of instruments and now we are terrified of the auditors. If things go on like this, I'm afraid that pencils will find their way into "Capital Construction."

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OBITUARY

We regret to record the deaths of:

MR. WILLIAM COLLINS, on December 4 at the age of 58. He was manager of the erection department at the Staveley Iron and Chemical Co. Ltd., Devonshire Works, Staveley, near Chesterfield, Derbyshire, and had been associated with the firm for more than 30 years.

MR. EWART FREDERICK FOSTER, M.Inst.F., on December 9, at the age of 56. He had been for many years one of the senior sales representatives of George Kent Ltd., Luton, Beds., in the United Kingdom. Mr. Foster joined the company in January, 1915, and, after serving in the 1914-18 war, worked in the production control and drawing offices. In 1924 he was appointed a sales representative based on the firm's office at 199, High Holborn, W.C.1.

MR. JAMES WILLIAM CANDELIN, on December 4, in his 53rd year. Mr. Candelin was export manager to Raybestos-Belaco Ltd., makers of brake linings, clutch facings and fan belts, Everite House, Southwark-street, London, S.E.1. He joined the company in 1944 and was appointed export manager in 1948.

MR. WILLIAM RAMSAY LOUGH, at Newcastle-upon-Tyne, on December 14 at the age of 74. Before his retirement four years ago, Mr. Lough was chairman and joint managing director of Robert Frazer & Sons Ltd., iron and steel merchants and wagon repairers, Hebburn-on-Tyne. He had been with the firm for 52 years having started as a junior clerk.

MR. JOHN BONEHAM, M.B.E., at his home in Mansfield, Nottinghamshire, at the age of 70. He had been associated with the engineering industry all his life and in 1918 founded the firm of Boneham and Turner Ltd., engineers and tool makers, Mansfield. He was awarded the M.B.E. in 1943.

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ELECTRICITY SUPPLY IN NOVEMBER

9·5 Per Cent. Increase over 1954

During November, 1955, 6,382 million kWh were sold by the Central Electricty Authority to the English and Welsh Area Boards. This was an increase of 8·7 per cent. over the figure for November, 1954. Allowing for the weather conditions and for the number of effective working days the increase was 9·5 per cent.

The amount of electricity sent out by the Area Boards during the same months was also 6,382 million kWh, of which 159 million kWh were supplied direct by the Central Authority. The increases in the amounts sent out, compared with the corresponding figures in November, 1954, were 7·3 per cent. in the "mainly industrial" and 10·5 per cent. in the "mainly non-industrial" areas.

PERSONAL

The Council of the Air Registration Board have appointed SIR MILES THOMAS, D.F.C., M.I.Mech.E., chairman and chief executive officer of the British Overseas Airways Corporation, to be a member of the Board. Sir Miles was nominated by the operators to fill the vacancy on the Board caused by the resignation of MR. WHITNEY STRAIGHT, C.B.E., M.C., D.F.C.

The resignation of SIR EDWARD C. BULLARD, Sc.D., F.R.S., from the directorship of the National Physical Laboratory takes effect on December 31. The appointment of a successor to Sir Edward will be announced in due course, but pending this, DR. R. L. SMITH-ROSE, C.B.E., D.Sc., M.I.E.E., director of radio research in the Department of Scientific and Industrial Research, will be acting director with effect from January, 1, 1956.

CAPTAIN C. W. JONES, M.I.Mech.E., A.F.R.Ae.S., R.N., has been appointed a Royal Naval Aide-de-Camp to the Queen in succession to CAPTAIN C. P. GALLIMORE, R.N.

DR. T. P. HUGHES, M.A., has been appointed director of the research laboratories at Hinxton Hall, Cambridge, of Tube Investments Ltd., The Adelphi, London, W.C.2. DR. F. P. BOWDEN, F.R.S., is the chief research consultant to the firm.

MR. K. J. B. WOLFE, M.Sc., has been appointed head of fundamental research by the Triplex Safety Glass Co., Ltd., and will take charge of the company's new research department to be built at their Willesden factory in West London.

PROFESSOR F. B. HINSLEY has been awarded the sixth Douglas Hay Medal of the Institution of Mining Engineers, in recognition of his many valuable contributions on natural and mechanical ventilation, air-flow research and the study of climatic conditions in hot and deep mining.

DR. R. B. KILLINGSWORTH, F.Inst.Pet., manager of the technical department of the Mobil Oil Co. Ltd., Caxton House, London, S.W.1, since 1952, returned to the United States on December 14. He has been succeeded by MR. G. A. DICKINS, B.Sc., A.R.I.C., F.Inst.Pet., hitherto assistant manager of the technical department.

MR. T. R. HARDMAN has been appointed general manager of Tecalemit Ltd., Plymouth and Brentford.

MR. N. MCK. COCKSHUTT, deputy managing director of Leyland Albion (Africa) Ltd., has retired. Following this four new directors have been elected, namely, MR. R. J. DUNLOP, general sales and service manager, MR. P. B. DE PUTRON, manager, Central African territories organisation, MR. P. CORNES, Cape Town depot manager, and MR. H. MARTIN, Durban depot manager.

MR. F. WIDNALL, B.Sc., M.I.E.E., head of the lighting-equipment engineering department, British Thomson-Houston Co., Ltd., Rugby, has been appointed manager of the company's lighting-fittings factory at Hereford.

MR. J. N. M. LEGATE, B.Sc., A.M.I.E.E., has been made assistant chief engineer, industrial control department, Metropolitan-Vickers Electrical Co. Ltd., Trafford Park, Manchester, 17.

MR. F. W. HALLIWELL, C.B.E., M.I.Mech.E., M.I.Prod.E., has been re-elected President of the Gauge and Tool Makers' Association, Standbrook House, 2-5 Old Bond-street, London, W.1.

MR. E. HELIOT has been elected President of the British Association of Machine Tool Merchants, St. Stephen's House, Victoria Embankment, London, S.W.1, in succession to MR. A. V. GRAVES.

After 30 years as joint managing directors of John and E. Sturge Ltd., Wheeleys-road, Birmingham, MR. A. L. WILSON and MR. A. P. WILSON are relinquishing their positions at the end of the present year. They will continue on the board as chairman and deputy-chairman respectively. MR. A. R. FOXALL and DR. E. R. S. WINTER have been appointed joint managing directors as from January 1, 1956. MR. J. A. WATSON is continuing as secretary and finance director.

The Iranian Oil Exploration & Producing Co., and the Iranian Oil Refining Co. in Tehran announce that MR. L. E. J. BROUWER is to leave Tehran towards the end of March, 1956, in order to assume a position of high responsibility in the Royal Dutch/Shell group. He will be succeeded as general managing director of the two operating companies in Iran by the Dutch mining engineer, MR. K. SCHOLTENS, who has, at present, a senior position on the Bataafsche Petroleum Maatschappij, the main Netherlands operating subsidiary company of the Royal Dutch/Shell group.

COMMERCIAL

THE DOWSON AND MASON GAS PLANT CO. LTD., have changed their name to DOWSON AND MASON LTD., Alma Works, Levenshulme, Manchester, 19, from December 12. The change has been thought desirable on account of the extension of the firm's activities in recent years.

THE BRITISH PETROLEUM CO. LTD. announce that the B.P. GROUP, through their wholly-owned subsidiary company, D'ARCY EXPLORATION CO. LTD., have entered into an agreement to participate in the programme recently announced on oil exploration in New Zealand by the SHELL GROUP and TODD BROTHERS LTD. Prospecting licences in the Taranaki and Rangitikei areas are held by Todd Brothers Ltd. and the Shell Group, and exploration is to be carried out by the recently-formed SHELL D'ARCY TODD OIL SERVICE LTD.

The offices of the INSTITUTE OF REFRIGERATION are now situated at New Bridge-street House, New Bridge-street, London, E.C.4. (Telephone: CENtral 4694.)

Subject to the completion of formalities, agreement has been reached for the acquisition by TUBE INVESTMENTS LTD., The Adelphi, London, W.C.2, of the whole of the issued share capital of the POWER CENTRE CO., LTD., Wednesbury and Walsall. The separate identity of the Power Centre Co. will be preserved.

WADKIN LTD., Green Lane Works, Leicester, have arranged to acquire a group of four woodworking-machinery manufacturing companies by the purchase, with effect from January 2, 1956, of the whole of the issued share capital of J. SAGAR & CO. LTD., Canal Works, Halifax, the parent company. The three wholly-owned subsidiary companies of this firm are SAGAR BURSGREEN LTD., Canal Works, Halifax; BURROWS GREEN LTD., Trawden, Colne, Lancashire; and HOUGHTON ENGINEERS LTD., Houghton-le-Spring, Co. Durham. MR. J. B. BULLIVANT, deputy chairman of Wadkin Ltd., will be appointed chairman of J. Sagar & Co., and all its subsidiary companies, and other directors of Wadkin Ltd. will be appointed to the various boards. The present chairman of J. Sagar & Co., MR. H. GORDON SAGAR, will remain a director of that company, and MR. J. G. SAGAR, as the managing director, and the managing directors of the subsidiary companies, will also continue in their present capacities. MR. J. G. SAGAR is to be appointed a director of Wadkin Ltd.

A.C.V. SALES LTD. announce that the Maudslay spares store is now located at the Maudslay factory, Alcester, Warwickshire. Inquiries should therefore be addressed to A.C.V. SALES LTD., Spares Depot, Castle Maudslay, Alcester, Warwickshire (Telephone: Alcester 181, Ext. 24) and not to Coventry as hitherto.

THE SUDAN ROAD ASSOCIATION, P.O. BOX 314, Khartoum, has been formed. It is affiliated to the INTERNATIONAL ROAD FEDERATION LTD., 18 South-street, London, W.1, which has now 53 national road associations operating throughout the world.

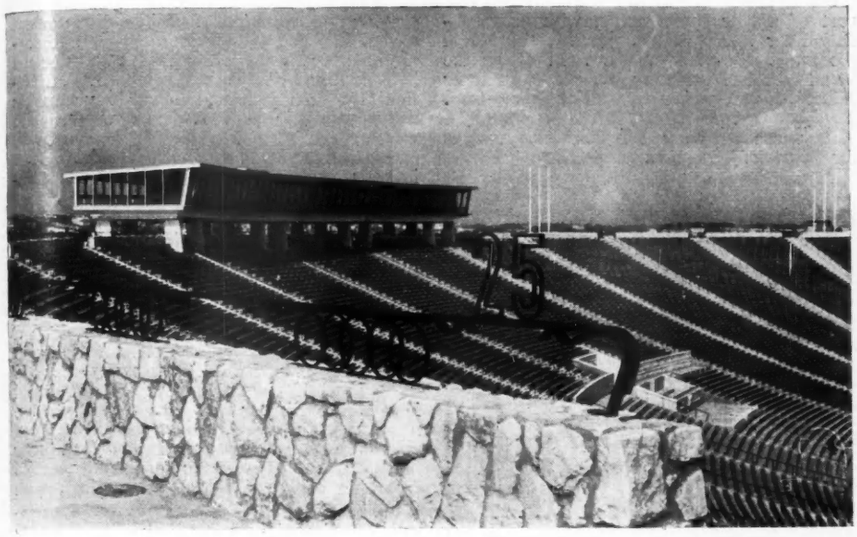
FAWCETT, PRESTON & CO. LTD., Bromborough, Cheshire, and FINNEY PRESSES LTD., Birmingham, have formed a joint sales and service company with the title, FAWCETT-FINNEY LTD., with head office and Midland region sales headquarters at 27 Berkley-street, Birmingham. Branch offices for London and Southern region sales, and for Northern region sales, have been established at 60, Buckingham Palace-road, London, S.W.1, and at Bromborough, respectively. A Western region sales office has been opened at Mayfield Park South Fishponds, Bristol.

The Clifton dynamic balancing machine, previously marketed by DAWE INSTRUMENTS LTD., 99 Uxbridge-road, Ealing, London, W.5, and described on page 88 of our issue of July 15, 1955, is now being sold by SMALL ELECTRIC MOTORS LTD., Eagle Works, Churchfields-road, Beckenham, Kent. This firm hold the patent rights and are the manufacturers. Dawe Instruments Ltd. are augmenting their own range of balancing machines by the production of a large console model to be shown at next year's Physical Society Exhibition.

QUASI-ARC LTD., Bilston, Staffordshire, are now the sole licensees in this country and the Commonwealth for HELIARC welding equipment.

THE UNION CARBIDE AND CARBON CORPORATION, 30 East 42nd-street, New York 17, U.S.A., have concluded an agreement with PHILLIPS PETROLEUM CO. for a licence under the Phillips patents involving polyethylene, a high-strength semi-rigid thermoplastic material. Under the agreement the Corporation have rights to produce polyethylene of the general types identified by the Phillips trade mark "Marlex."

The new address of the GYPSUM BUILDING PRODUCTS ASSOCIATION is G.P.O. BOX No. 321, London, W.1. This address will also be that of the *Gypsum Journal*.



Sports arena in the Praga district, Warsaw, showing the Press box. In Poland architectural design has been influenced by modern materials and methods of construction.

TOWN PLANNING AND BUILDING IN POLAND

INDUSTRIALISATION THE KEY TO NEW DEVELOPMENTS

Until this year, information concerning the countries of the Soviet bloc has been extremely limited, but recently with the relaxation in Soviet policy a number of technical delegations have made exchange visits, and some details of industrial and engineering activity have become available. On November 22 a Polish building delegation led by the Minister of Industrial Building, Mr. Czeslaw Babinski, and the Minister of the Building Materials Industry, Mr. Stefan Pietrusiewicz, arrived in this country for a visit of 18 days. Their tour included the Building Exhibition, the Building Research Station, the laboratories of the Cement and Concrete Association, the new town of Crawley, and various other industrial and domestic building sites; they also visited the premises of several industrial firms, including Blaw, Knox, Limited, and Winget, Limited, concerned with the production of building materials or equipment. In an interview, Mr. J. Zakowski, vice-Minister of the Ministry for the Construction of Towns and Settlements, and Professor M. Kaczorowski, Director of the Institute of Town Planning and Architecture, gave some impressions of their visit and revealed details of current industrial and building activity—with particular reference to new towns—in Poland.

PREFABRICATION

During their tour of building sites in this country the Polish delegation were much impressed by the thoroughness and good organisation of site work and by the high standard of finish in domestic housing. Fittings were of excellent quality and the use of plastics in such components as coloured tiles represented a notable advance. They were also impressed by the quality of British bricks and building equipment; in particular they considered that a mobile 20 ton cement mixing plant, which they inspected, designed for export to India, would also serve a useful purpose in Poland.

The differences between housing in Britain and in Poland largely arose from climatic conditions; Poland was subject to wide extremes of temperature and consequently costly heating was necessary, together with double windows and thicker walls. These heavy walls were able to support considerable loads, and multiple stories were therefore possible without additional reinforcement. Good quality bricks were not abundant and this, together with the need to build quickly, had led to the extensive use of prefabricated construction employing concrete blocks. Work of this kind can be seen in the illustration below, which shows flats being built near Poznan.

NEW TOWNS

But probably the greatest influence on Polish building and town planning since the war had been the call for industrialisation. This was illustrated by the construction of new towns based on single industries, and Nowa Huta near Cracow, which was centred on a new steel plant of four million tons a year capacity, and Nowa Tychy in Silesia, built to accommodate workers from the coalfield, were examples. Nowa Huta, which was already half finished, was to house 120,000 people and Nowa Tychy 100,000. Before the construction of Nowa Tychy, there had been considerable congestion in an area subject to widespread subsidence due to the mining of coal near the surface; the new town had been built on the edge of the basin and was only 40 minutes journey from the centre.

LIGHT INDUSTRIES: WATER CONTROL

In addition, it had been the Government's policy to introduce light industries into the new towns to provide work for the women inhabitants. Accommodation was largely in the form of flats but houses had also been built, particularly for miners. All dwellings were checked by local government inspectors and could only be put in service after issue of a certificate. Flats were generally of four or five stories, and constructed from large concrete elements, as shown in the illustration, and consequently tower cranes were in considerable demand. Use was also made of lightweight cellular concrete prepared under licence from Sweden.

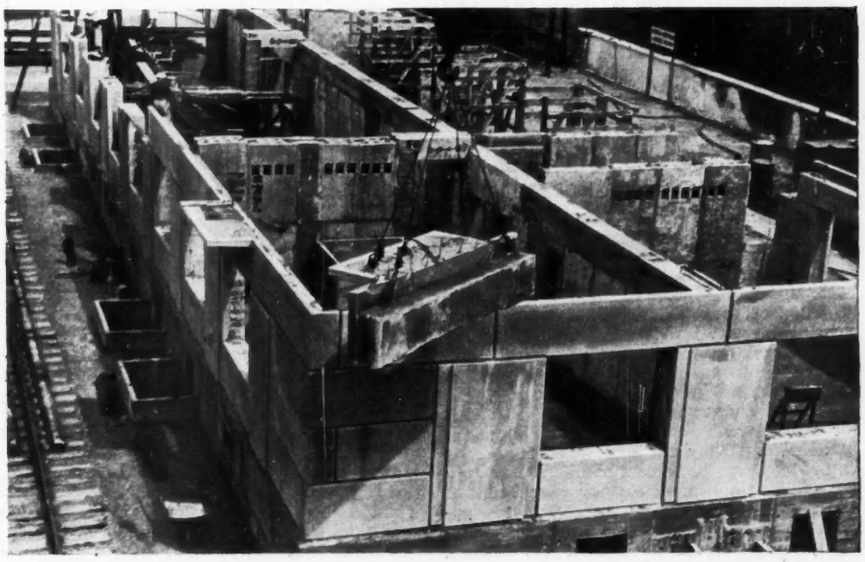
Warsaw too had played its part in the general plan of industrialisation and new factories for the manufacture of textiles, radio equipment, non-ferrous metal components, motor cars and precision instruments had been built. Poland had also now a growing plastics industry.

Two hydro-electric schemes, one on the Vistula and another on a smaller river, which had been started before the war, were now completed, and in view of the water-supply problem in Silesia an overall plan for water control was under consideration. It was also of interest to note that a 46 hour week was worked—8 hours including a 20 minute lunch break for five days a week, and 6 hours on Saturday.

AS DEAD AS THE DADO

The reconstruction of Warsaw itself had been carried out on a considerable scale with many of its buildings restored to pre-war style, but modern architecture was also much in evidence, particularly in new suburbs such as Praga II. Buildings did not exceed nine stories, although wide use was made of reinforced concrete in building construction.

It may be interesting to recall that recent comment in the Soviet Press has been severely critical of the grandiose, almost Victorian character of contemporary Russian architecture; architects have been indicted for extravagance



The need to build quickly and the inadequate supply of bricks led to the wide adoption of prefabricated construction in Poland. Flats are usually of four or five stories and built from large concrete elements. The growth of new towns based on single industries has created considerable demand for domestic and industrial building, and for this purpose extensive use has been made of prefabricated construction.

in designing " unnecessary dado ornamentation," " superfluous cornices " and " expensive pilasters and columns." Poland, on the other hand, appears to have been unaffected by the artificial splendour of the Stalin era and has in general permitted modern methods and materials to determine her architectural style. An illustration of this is given in the other picture, which shows part of a new sports arena, with accommodation for 71,000 people, which is situated in the Praga district of Warsaw. In design the arena combines an outer circle with an inner ellipse between which the seating is confined. The glass and concrete structure supported on stilts, which can be seen in the background, is for the use of journalists.

IMPROVING WEIGHTS AND MEASURES

CONFERENCE IN THE UNITED STATES

The American National Bureau of Standards has recently issued the report* of the 40th National Conference on Weights and Measures, 1955, which was held in Washington, D.C., and attended by official delegates and guests from central, state and local government, as well as representatives of manufacturing, trading and business organisations. The Conference received and considered a number of addresses, reports, papers and symposia covering many aspects of weights and measures in the United States. The subjects ranged from improved techniques in the measurement of high-energy X-rays to the manufacture of paper milk containers and liquified petroleum-gas meter provers.

In the opening address, the Hon. Walter Williams, Under Secretary for Commerce, described the work of the Bureau and its value to industry, quoting the Bureau's own " MDE—Modular Design of Electrons," a new concept of electronic design utilising the " building block " principle which makes possible mechanised production. One firm had already set up a plant to produce component parts for TV sets by the modular system. A study made of one company's assembly-line production of an eight-valve radio frequency receiver by this system for the armed forces revealed an impressive total saving of 44 per cent. over conventional manufacture.

Mr. A. I. Astin, director of the Bureau, in his presidential address, reported on the year's work. A new laboratory, costing 4 million dollars, had been completed at Boulder, Colorado, and the Radio Propagation and Standards work, with associated staff, had been moved there. As the U.S.A. government representative to the 10th General Weights and Measures Conference in Paris last year, he spoke, very briefly, of two of its activities. A new thermodynamic temperature scale had been adopted primarily for scientific purposes where it was much needed for investigation into the properties of materials at extreme temperatures. Consideration had also been given to the re-definition of the international standard of length, and the development of a better fundamental standard. It had been agreed, in Paris, that the international metre should be defined and referred to the properties of atoms rather than to a platinum-iridium bar. No agreement had been reached as to the particular atom or to the conditions which should be used, but all the great laboratories of the world were to study this problem so that a decision might be reached at the next General Conference, planned for 1960.

He also referred to three important technical achievements at the Bureau during the year. First there was a discovery in fluid dynamics, of particular importance to supersonic aircraft, as it related to the transition from laminar flow to turbulent flow round aircraft structures. The second was concerned with improved techniques for measuring high-energy X-rays. Using their betatron, a facility for generating 50 million volt X-rays, new equipment had been developed for detecting the presence and energy content of such X-rays. By using this detection equipment in association with modern television equipment, a system for looking at the internal parts of moving metallic objects had been developed. This had been applied specifically to looking at the inside of an operating petrol engine—possibly the first time this had been done and a most important new test for mechanical engineers. The third involved the application of the techniques of physical science to medical sciences by the production of an instrument to record automatically critical physiological characteristics of a patient during a surgical operation.

The following are brief résumés of some of the papers and symposia presented to Conference.

1,000 LB. TESTING BALANCE

Mr. H. H. Russell, of the National Bureau, gave a description of a new 1,000 lb. balance constructed for comparing 500 lb. and 1,000 lb. weights used in the testing of road weighbridges installed throughout the United States. During the past two decades the very rapid growth in highway freight transportation had led to more and bigger freight carriers. Weight and distance were the main criteria for freight cartage costs and as a result more weighbridges, larger in length and capacity, were being installed over the States. Extensive tests with a specially equipped weighbridge testing unit had proved that ordinary tests with 50 lb. weights were inadequate and rarely reached a sufficiently large test load. To meet this new need, weights and measures organisations were providing more and more 500 lb. and 1,000 lb. test weights, for the calibration and regular verification of which the States looked to the National Bureau. As a result, a new 1,000 lb. balance has been designed and built with modifications to overcome the difficulties of handling large weights. Mechanical means had been incorporated into the balance for lowering the entire balance until the suspension hooks could be engaged with the weights; raising the whole assembly with weights suspended for test purposes; and complete rotation of the assembly for easy handling of the weights and the reversing of the beam.

PROVING LP-GAS METERS

A symposium on the above subject was introduced by Mr. R. E. Meek, director, Division of Weights and Measures, Indiana, containing all available new data as put forward by representatives of various organisations interested in the proving of meters for the sale of liquefied-petroleum-gas.

Liquefied-petroleum gas (LP-gas) is sold and distributed in many ways and some means had to be found for measuring the amount sold. Currently it was sold and measured principally by weight, vapour volume and liquid volume, and it is the problems attached to the sale by the liquid-volume method, through positive displacement meters, that principally concern the LP-gas industry. LP-gas meters, subject to wear and tear and consequent inaccuracy, must be installed in the dispensing system to be accurate and some reliable means must be found not only to check and prove the meters but also the entire metering system. The aim is to produce a meter prover which would be accurate, simple to operate, reasonable in cost, low in operating time, and readily portable.

In 1941 the American Petroleum Institute and the American Society of Mechanical Engineers developed a project to study the results of volumetric research and as a result produced the A.P.I. Code (No. 1101) for the installation, proving and operation of positive-displacement meters in liquid hydrocarbon service. Recognising that it is the whole system and not the individual meter which has to be proved, attention had been narrowed down to volumetric and gravimetric provers. State weights and measures officials and petroleum companies, who had studied these problems and developed provers in their own territories, reported to the Conference.

The Philips Petroleum Company selected for testing the " hydrostatic " volumetric method; this method is hydrostatic in that the prover tank is filled with liquid and volumetric in that the proving is done on the basis of volume directly, and not on weight (afterwards converted to volume). This method involved the use of a pressure vessel (prover tank) of known volume which was purged with LP-gas vapours and " spray loaded " liquid full with LP-gas pumped into the meter under test. The accuracy of the meter was determined by comparing the known volume in the prover tank (corrected for vapour in the tank at the start of the test and any thermal expansion of the liquid after metering), with the meter reading. Calculations showed that this prover would be accurate to within plus or minus 1 per cent. A number of field tests indicated that this meter prover was entirely satisfactory and fulfilled all the aims. The time taken for a complete proving run was approximately 30 minutes. Further field tests were being made.

The Suburban Rulane Gas Company built and tested a volumetric prover as part of its research programme. The object was to evaluate the volumetric and gravimetric methods and a system was planned that could be readily changed to either. For field purposes another prover of the volumetric type, mounted on a trailer, was constructed. After extensive tests of both methods the conclusion reached was that the trailer prover was accurate to within plus or minus 1 per cent., allowing for human errors. Such a trailer could be constructed at a cost of between 1,200 and 1,500 dols.

The Skelly Oil Company also constructed a volumetric and/or gravimetric prover, though not of the portable type as they required it for LP-gas bulk plants. From experience gained they were of the opinion that field provers could be constructed of 30 gallon capacity which were simple in construction and use, with a reasonably high degree of accuracy.

The Neptune Meter Company also contributed a paper in which comparisons were drawn between different metering methods. The conclusions reached included: all gravimetric methods are less accurate in windy days because of the aerodynamic effects on the prover tank when being weighed; in gravimetric tests, the weighing is done on commercial machines rather than by comparing with a fundamental standard; and the different methods of weighing leave much to be desired. The final conclusion reached was that straight volumetric measuring (with pressure-equalised line) is as good, if not better, than the other method.

OTHER PAPERS AND REPORTS

Investigation into the gauging and testing of farm milk tanks had been undertaken by the National Bureau and a report was submitted which bore out the accepted conclusion that tolerance on a device involving graduation readings was subject to human errors. It was incorrect to expect that $\frac{1}{32}$-in. graduations would double the accuracy and precision afforded by $\frac{1}{16}$-in. graduations and in certain instances there might be less accuracy with the former. The current system of measuring milk in farm milk tanks did not offer expected commercial accuracy but owing to the enormous growth of the system, efforts should be made to increase both the accuracy and the precision of this method of measuring milk.

Papers were also presented on (*a*) factors contributing to package fill variation; (*b*) paper milk containers, and (*c*) a new system of packing milk and other fluids.

* *Report of the 40th National Conference on Weights and Measures*, 1955, Miscellaneous publication No. 216 of the National Bureau of Standards, United States Department of Commerce. (70 cents.)

BOOKS RECEIVED

Some of the books noticed here are selected for extended review in ENGINEERING.

Knife-Edge Bearings. A Bibliography of Instrument Parts, No. 2. By P. J. GEARY. *British Scientific Instrument Research Association, South Hill, Chislehurst, Kent.* (10*s.* 6*d.*)

This bibliographical survey on instrument parts covers the period from 1900 to the present date. It comprises a technical introduction, an annotated bibliography of 166 references (the more important ones with fuller digests) and a name index. The introductory technical review covers knife-edge bearings in balances, weighing machines, and strength-testing apparatus, for transmitting small movements in mechanical comparators and extensometers, as armature pivots in electro-magnetic relays, and as pendulum suspensions; the loads knife-edge bearings can carry; the forms and included angles of knife edges and V-grooves; materials; making, examining, and mounting knife-edge components; friction, wear, and impact in knife-edge bearings; preventing corrosion in steel bearings; varieties of bearings devised by inventors.

The Canadian Standards Association Approvals System: Information for U.K. Manufacturers Exporting Electrically-Operated Equipment to Canada. Second edition. *British Standards Institution, 2 Park-street, London, W.*1. (5*s.*)

This edition of a booklet, which first appeared in 1952, is intended to strengthen the approvals service, which the British Standards Institution operates as agent for the Canadian Standards Association. This service enables equipment to go straight into service in the Dominion without the risk of it being returned to this country for costly alterations. A number of alterations and additions have been made including one relating to the approval of equipment incorporating pressure vessels for which there are special requirements when the capacities and pressures exceed certain limits. The existence of a consultative service concerned with the export of special kinds of wire and cable not subject to approval in the usual way is noted. The lists of Canadian approved specifications and of provincial chief electrical inspectors have been brought up to date and details of related British Standards publications are included for the first time.

Collins Aero Diary, 1956. New edition, revised and rewritten. *William Collins Sons and Company, Limited, 144 Cathedral-street, Glasgow, C.4.* (5*s.* 9*d.*)

The technical data at the front of the diary, which have been completely revised, comprises data on aerofoil characteristics including compressibility effects, notes on flap characteristics, slats and nose flaps; propeller theory; performance estimation including a brief discussion of transonic and supersonic performances; helicopters; gliding; flight load analysis; mechanics of materials and structures, including notes on strain gauges, tables of bending moments and deformation for uniform beams, torsion constants of non-circular sections, centroids, moments of inertia, shear centre and warping constant of thin-walled sections, and creep and fatigue behaviour. Tables of logarithms and anti logarithms are included, and photographs of the Flying Bedstead, Britannia, Comet 3, Viscount 700, Gannet, Javelin and Hunter.

Benzene Vapour. Methods for the Detection of Toxic Gases in Industry, Leaflet No. 4. Second edition. Published for the Department of Scientific and Industrial Research by *H.M. Stationery Office, Kingsway, London, W.C.*2. (1*s.*)

A new method of test is described for determining the presence and amount of benzene in industrial atmospheres. The test is still based on the use of a formolite reagent and the assessment is made by comparison with a standard colour. An improved form of bubbler renders the test more sensitive and the use of a standard rubber-built aspirator in place of the hand pump specified in the original edition of this pamphlet makes for greater accuracy.

A Cross Reference Index between the 12th and 13th Editions of the Institution of Electrical Engineers Regulations for the Electrical Equipment of Buildings. *The Association of Supervising Electrical Engineers, 23 Bloomsbury-square, London, W.C.*1. (Gratis.)

This cross-reference index between the twelfth and thirteenth editions of the Regulations of the Institution of Electrical Engineers for the Electrical Equipment of Buildings has been published primarily to enable members of the Association who have become familiar with the earlier edition to accustom themselves quickly with the format of the new edition. The regulation numbers in the twelfth edition are placed on the left-hand side of the page with the numbers of the corresponding regulation in the thirteenth edition on the right. In the centre of the page is a reference to the subject matter. The index is intended for use pending the issue of a revised edition of the Association's Guide, which will be available early in 1956.

Problems and Control of Air Pollution. Proceedings of the First International Congress on Air Pollution held in New York City, March, 1955, under the Sponsorship of the Committee on Air-Pollution Controls of the American Society of Mechanical Engineers. Edited by FREDERICK S. MALLETTE. *Reinhold Publishing Corporation, 430 Park-avenue, New York 22, N.Y., U.S.A.* (7·50 dols.); and *Chapman and Hall, Limited, 37 Essex-street, London, W.C.*2. (60*s.*)

The book contains the principal papers given at the first International Congress on Air Pollution. Among the papers are those by Sir Hugh Beaver on the growth of public opinion, and by Mr. G. E. Pendray on management aspects of air pollution. The other papers fall into four main sections: gaps in the available knowledge on air pollution; current developments in air pollution; sulphur dioxide, treatment and recovery; experience in air pollution outside the U.S.A.

Freezing and Thawing Tests on Cement Mortar. (In Swedish.) By SVEN G. BERGSTRÖM. Bulletin No. 32. *Swedish Cement and Concrete Research Institute, Royal Institute of Technology, Stockholm, Sweden.* (2 Swedish Kroner.)

The purpose of the tests described in this paper was to study the effects produced on the frost resistance of cement mortar by variations in the mix proportions, in curing conditions, and in the degree of compaction. The methods of testing employed and the results found are fully described. In particular, autogeneous healing during thawing was found to be of significance in respect of the rate of deterioration. Non-destructive methods of testing and observing changes of quality were used, and notes are given on the applicability of the methods employed. An English summary is appended to the paper.

Applied Electricity. By H. COTTON. Fourth edition revised. *Cleaver-Hume Press, Limited, 31 Wright's-lane, Kensington, London, W.*8. (20*s.*)

The latest edition of Professor Cotton's well-known textbook, which was first published in 1951, contains an additional chapter on the analogy between the electric, magnetic and dielectric circuits. The symbolism has also been brought into line with the latest British Standards recommendations. The book is based on the syllabus of Part 1 of the London B.Sc. (Eng.) examination but is also suitable for syllabuses of the Joint Section A of the Institutions of Civil and Electrical Engineers, for the City and Guilds Intermediate Grade examination and for Ordinary National Certificate work.

Wechselräderberechnung. By OTTO LICHTWITZ. Part 20 of Werkstattkniffe. *Carl Hanser Verlag, Leonhard-Eck-Strasse 7, München 27, Germany.* (5.80 D.M.)

This little book of 111 pages is the twentieth of a series of monographs. It deals with the calculation of change gears, particularly for machine tools. The author employs analytical geometry for his calculations. After an introductory discussion of the mathematical principles, he gives many examples for the calculation of change gears and describes their application, particularly for lathes. Seven tables, covering rather more than 30 pages, are given as an aid for calculations.

Stahlleichtbau von Maschinen. By K. BOBEK, A. HEISS and FR. SCHMIDT. Second edition. *Springer-Verlag, Reichpietschufer 20, Berlin, W.*35. (24 D.M.)

This second edition of "Light Steel Construction of Machinery" is designed to meet existing needs for economy by making lighter construction possible through improved materials, new principles and methods of production. With this in view the contents are drawn up to serve the needs of practical constructers of welded steel assemblies. Although not much is said about the actual welding processes, greater attention is paid to judging the strength of work carried out by this method. The combination of casting and welding is also dealt with. Sections are contributed by three authors on examples of the application of this method to electric machines, machine tools, and internal combustion engines. The book is fully illustrated.

Power Plant Management. By ROBERT HENDERSON EMERICK. *McGraw-Hill Book Company, Incorporated, 330 West 42nd-street, New York 36, N.Y., U.S.A.* (6.50 dols.); and *McGraw-Hill Publishing Company, Limited, 95 Farringdon-street, London, E.C.*4. (49*s.*) (Reviewed on page 817, in the issue of December 16.)

TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Sequence Timers. ELECTRICAL REMOTE CONTROL CO. LTD., South-road, Temple Fields, Harlow New Town, Essex. Heavy-duty multi-circuit sequence timers for controlling a continuously repeating cycle of operations. Synchronous motor drive, interchangeable contacts, switching capacity 15 amperes at 240 volts. Timing range 1 sec to 30 days. Illustrated leaflet.

Refractory Ware. THE THERMAL SYNDICATE LTD., Wallsend, Northumberland. Refractory ware for insulators, crucibles, combustion boats, filtering devices, furnace tubes and cores, mortars and pestles, tubes and rods, etc.; made from mullite, alumina, magnesia, spinel, zircon, zirconia or thoria. Illustrated booklet.

British Railways. BRITISH TRANSPORT COMMISSION, 222 Marylebone-road, London, N.W.1. *Facts and Figures about British Railways* is small booklet giving the principal statistics regarding financial results and the carrying and other activities of British Railways, including also shipping services of the B.T.C.

Hydrochloric Acid Plant. THE THERMAL SYNDICATE LTD., Wallsend, Northumberland. Use of Vitreosil (pure fused silica) in HCl plant for acid-resisting duties; salt-sulphuric and by-products plant, gas absorption vessels, absorption tower sections, synthetic plants and gas burners. Illustrated leaflet.

Line Output Pentode and Rectifier Valve. MULLARD LTD., Shaftesbury-avenue, London, W.C.1. Output pentode for the line time bases of television receivers using picture tubes with a deflection angle of 90 deg. Half-wave power rectifier valve for television receivers with series-connected heaters. Illustrated data sheets.

Floor Cleansing Machines. MATLING LTD., Park-lane, Fallings Park, Wolverhampton. Battery or mains-powered dry-scrubbing, wet-scrubbing, drying, and polishing machines; air-powered polishing and scrubbing machine. Illustrated leaflet.

Geiger and Scintillation Counters. EL-TRONICS, INC., 431 Fifth-avenue, New York, 16, U.S.A. Geiger and scintillation counters for oil and uranium field mapping. Sensitiveness, ruggedness and reliability. Tropicalisation an added feature. Illustrated leaflet.

High-Vacuum Drying. NARESCO EQUIPMENT CORPORATION, 160, Charlemont-street, Newton Highlands, Massachusetts, U.S.A. Equipment for drying frozen biological specimens in the laboratory. Specification leaflet.

Mobile Compressors. HYMATIC ENGINEERING CO. LTD., Redditch, Worcestershire. Hymatic Hydrovane rotary air compressors, trolley-mounted, driven by electric motor or petrol engine. Illustrated descriptive leaflet with specification.

Rubber Seals for Concrete Structures. HALL & HALL LTD., Oldfield Works, Hampton, Middlesex. Rubber waterstops to prevent seepage through joints in concrete structures. Illustrated leaflet.

Feeding, Screening, Conveying, Filling. OWL ENGINEERING SUPPLIES LTD., Vibrator conveyors and screening machines manufactured by Jöst G.m.b.H., Germany. Illustrated descriptive brochure and specifications.

Torque-Arm Units. J. H. FENNER & CO. LTD., Marfleet, Hull, increased range of "torque-arm" shaft-mounted speed reducers with capacities up to 30 h.p. Technical details and dimensions. Illustrated booklet.

Variable-Speed Motor Control. M.T.E. CONTROL GEAR LTD., Leigh-on-Sea, Essex. Details of a new system of infinitely variable speed control for direct-current motors based on the saturable reactor principle. Illustrated leaflet.

P.T.F.E. DUNLOP RUBBER CO. LTD., Cambridge-street, Manchester. Polytetrafluorethylene mouldings, machined items, roller coverings, spray coatings. Chemical and physical properties and applications. Illustrated booklet.

Chain Drives. RENOLD CHAINS LTD., Wythenshawe, Manchester. Chain drives up to 140 h.p. in a wide variety of ratios. Illustrated leaflet, ref. 116/93.

Spray Guns. THE AEROGRAPH CO., LTD., 47, Holborn Viaduct, London, E.C.1. Applications of DeVilbiss Aerograph spray guns. Illustrated booklet.

Book Reviews

AMMUNITION FOR THE EDUCATIONAL BATTLE

Technical Education: Its Aims, Organisation and Future Development. By P. F. R. VENABLES. *G. Bell and Sons, Limited, York House, Portugal-street, London, W.C.2.* (42*s.*)

Technical education in this country suffers from the same disability as industry itself: it started too early. Its confused and heterogeneous character is due to its lengthy history in which the successive stages of manufacturing technique, the craft, the technical and the scientific, can all be traced. To-day much of the argument on the subject that so passionately occupies the time of industrialists, teachers and politicians is concerned to separate out the different levels and give each of them the support that the country's economic circumstances demand. After the publication of this book by the principal of the Royal Technical College, Salford, no one need lack the essential information on which to form a judgment about the forms, if not the curricula, of technical education, for it is a veritable encyclopaedia. Unfortunately, although it contains almost every relevant fact and statistic, it is so diffuse in style and repetitive in content that few will read it from cover to cover.

The heterogeneous and illogical character of our technical education is well illustrated by the fact that Dr. Venables covers the whole field of post-school education from courses in hairdressing and needlework, in art and commerce, to those of university degree and post-graduate level in the most advanced technologies. On the other hand, education in the universities is only discussed in passing. No doubt this arises out of the fact that technical education is the responsibility of a mere branch of the Further Education Division of the Ministry of Education and that technical colleges are almost entirely local authority controlled. This is, as Dr. Venables forcibly demonstrates, one of the great handicaps of pure technological education in the sense in which the word has now come to be used. Although local education authorities have been encouraged to appoint representative boards of governors for their colleges and give them some degree of freedom, in 1953-54, out of 198 colleges surveyed, only 32 had governors with full powers and 136 had governing bodies which were nothing but sub-committees of sub-committees of the education committees concerned.

To these handicaps to educational flexibility and freedom must be added the host of other pressures to which the staff of a technical college are subject. These include local industrialists, whose genuine co-operation Dr. Venables recognises as essential, and the large number of examining bodies such as the professional institutions, the Regional Examining Unions, the City and Guilds, the Royal Society of Arts and the University of London for external degrees who, as the need arose, have provided qualifications for students, but whose multifarious existence to-day sometimes exerts a cramping effect.

The origins of all this activity are to be found in the growth of mechanics institutes at the beginning of the last century, at a time when there was little general education for workmen. Later these developed as schools for craftsmen and, increasingly, for technicians; but, since the introduction of the National Certificate courses they have also formed the channel for those who do not go to a university to proceed to full professional standing in a modern technology, chiefly engineering. Many of our largest technical colleges and even some "red-brick" universities have followed this historical path.

To-day, however, this slow development is inadequate, for the increasing dependence of industry on science has raised the standards of training needed by the technologist. Hence the demand for further facilities for full-time advanced education, including sandwich courses, for work which cannot be satisfactorily carried out in evening classes or by part-time day release. Dr. Venables deplores the slow expansion of even day release over several decades and its small coverage even now (there are 36 evening students for every six part-time day students and each full-time student) and advocates the recognition of a small number of major colleges as regional colleges, provided they have high enough standards of staffing, covering several technologies and related sciences, and adequate research and post-graduate departments. Such colleges, at least the equal of most American urban universities, should be allowed to have their own Associateships accepted in lieu of the proposed new national Diploma in Technology. They would have to be largely independent of local authorities and quinquennielly grant aided through some body like the University Grants Committee. Dr. Venables believes that the new National Council for Diplomas in Technology, of which Lord Hives is chairman, will assist a development in this direction, but it must be recognised that the resources in staff are limited and, if standards are to be high, the number of such colleges must at first be small.

Important though education for technologists is, it must not be allowed to overshadow the great and growing importance of technicians and craftsmen, whose true needs have been obscured as the standards of National Certificate courses have been raised to meet professional needs and the requirements, even of the City and Guilds, have become more suitable for the technician than the craftsman for whom they were originally designed.

The increased flexibility in outlook which modern industry demands, and which improved provision for technical education could provide, will be impossible without a simultaneous increase in quality and duration of the general education given in the secondary schools. Dr. Venables tentatively supports the view that raising the school leaving age to 16 should take precedence over the starting of the much delayed county colleges, although he points out that of the whole county-college age group, between 15 and 17, an average of only 14 per cent. is at present receiving any education at all. The present school situation and the great diversity of ability among students is one of the difficulties which teachers in technical colleges face. There is urgent need for more research both into selection methods and into the teaching situation in technical education and, according to Dr. Venables, the recently established technical teachers training colleges ought to become vivifying centres of educational research which could also be organised in departments of social studies in the technical colleges themselves. There is here a wealth of interesting material to form the basis of discussion, though one cannot help wishing that Dr. Venables had omitted the enormous number of references to other people's opinions and had more sharply defined his own on some of the more difficult problems. It is to be hoped that others will use the results of his immense industry as ammunition in the urgent battle to give this country the technical education it so desperately needs.

THERMODYNAMICS AND GASEOUS PHYSICS

High Speed Aerodynamics and Jet Propulsion. Vol. I: Thermodynamics and Physics of Matter. Edited by FREDERICK D. ROSSINI. *Princeton University Press* and *Oxford University Press* (*Geoffrey Cumberlege*), *Amen House, Warwick-square, London, E.C.*4. (100*s.*)

How embracing in scope aeronautical engineering has become, and how thin now the line between theory and advanced development in that field, could not be better illustrated than by Dr. Rossini's book. Although in itself 800 pages long, it is only one of a series of twelve volumes relating to propulsion engines and to the aerodynamics of high-speed flight. All in all, over one hundred experts will have co-operated in this series to bring together in coherent form the information now basic to the related fields of gas dynamics, aerodynamics, combustion, and jet propulsion.

The volume here reviewed is one of the two or three in the series having to do with basic scientific principles rather than with the fundamental and applied sides of a specific technological area. It is a treatise primarily on thermodynamics and on gaseous physics, with a special effort made to include subject matter of particular significance to combustion processes, to flight at speeds so high that aerodynamic heating may be decisive, and to flight at altitudes so great that the rarefied gas must be considered as individual particles. Apart from these special aims, however, the volume has developed into a book of general reference value on the thermodynamics of matter treated in both macroscopic and microscopic frameworks.

The range and type of subject matter may be indicated by setting out the section headings: fundamentals of thermodynamics, fundamental physics of gases, thermodynamic properties of real gases and mixtures of real gases, the transport properties of gases and gaseous mixtures, critical phenomena, properties of liquids and liquid solutions, properties of solids and solid solutions, relaxation phenomena in gases, gases at low densities, and the thermodynamics of irreversible processes.

Much of the subject matter might be regarded by engineers as in the domain of theoretical physics, and this is true. Yet it is typical of the accelerating technology of the past two decades that some of the knottiest problems of engineering development are being solved by men having a training and knowledge which in earlier days might have been thought superfluous if not a handicap. It is in this context that the volume reviewed is significant. Most engineers working on aircraft and propulsion engines will need to grasp only a small part of what is in this book. But on the side of research and advanced development the volume contains fundamental knowledge which is of immediate consequence to the aeronautical problems of to-day and which will be even more important to those of to-morrow.

JANE'S AIRCRAFT

Jane's All the World's Aircraft, 1955-56. Forty-sixth year of issue. Compiled and edited by LEONARD BRIDGMAN. *Jane's All the World's Aircraft Publishing Company, Limited*, distributed by *Sampson Low, Marston and Company, Limited*, 25 *Gilbert-street, London, W.*1. (84*s.*)

As the world's aircraft industries expand, so does "Jane's," and this year's volume contains 410 pages of text, 30 more than last year. While the three largest sections, by nation, are still those of the United States, Great Britain, and France, it may be significant that the space devoted to British industry is nine pages less than last year, while America's contribution is larger by 14 pages and France's by three.

There are no major changes in the method of presentation, but non-scheduled airline operators are now included, together with scheduled air lines, in the section on "Civil Airline Operators." The main part of the book is, naturally, devoted to illustrated, tabular descriptions and data of current aircraft and engines of the various countries, and it is these comprehensive and authentic sections that are probably valued most by the industrial user. One of the virtues

of the work is that, where information is incomplete or speculative, as in the case of several Soviet Union aircraft, the fact is frankly stated.

Although Germany has not yet achieved a place in the aeroplane section, the editor records the first signs of a renaissance of the German aircraft industry, and notably of the Messerschmitt, Heinkel and Dornier firms. Prototype aircraft by Messerschmitt and Dornier have, in fact, been built and flown in Spain.

A special feature of this 46th volume is a contributed article, well illustrated by American pictures, by the president of the Aerojet-General Corporation. Describing guided missiles, it is broad in outline but includes a table which lists the functions, manufacture, type of propulsion, etc., of missiles now under construction or development in the United States.

In his preface, Mr. Bridgeman remarks that "the annual revision of *All the World's Aircraft* is a task of the first magnitude." We would agree, and would add that it is a task which he continues to carry through with great success.

PRINCIPLES OF HEAT ENGINES

Thermodynamics. By JOHN FRANCIS LEE and FRANCIS WESTON SEARS. *Addison-Wesley Publishing Company, Incorporated, Cambridge* 42, *Massachusetts, U.S.A.* (7·50 dols.)

It is often said that there are three kinds of thermodynamics written, respectively, for physicists, chemists and engineers and that, though any one may satisfy the needs of those to whom it is addressed, it is likely to be largely incomprehensible to readers belonging to either of the two other clases. Although the present volume forms part of a "Series in Mechanical Engineering," it is far from being just an other specialist text on technical thermodynamics suitable only for engineers. Its purpose is "to provide a mature approach to the basic principles of thermodynamics for all engineers and applied science students regardless of their ultimate professional objectives," and it may be added that there are few physics students who would not benefit from a study of it.

The laws of thermodynamics can be stated quite briefly: they appear to be valid everywhere without exception and it is a peculiar merit of the thermodynamic method that the results obtained by it are independent of any mechanical model that may be proposed in attempting to analyse the processes concerned. This gives to thermodynamics a somewhat abstract character and it is not always easy to decide just how thermodynamic arguments should be applied in order to arrive at absolutely unassailable conclusions. It is therefore essential that the student of thermodynamics should acquire a proper understanding of its basic principles and be trained to develop the power to reason from them before attempting to apply them to engineering or chemical problems.

The first seven chapters of this course are devoted to a thorough treatment of the first and second laws and their immediate consequences. The authors realise how many of the difficulties in thermodynamics arise because insufficient trouble and space is taken to explain clearly the meaning of such fundamental concepts as reversibility, temperature, etc., and have taken all reasonable precautions to remove possible misconceptions. The notation used has been carefully chosen to contribute to this end. Special symbols, for instance, are employed to distinguish between the specific value of a property, its average specific value and its *molal* specific value, while the use of the symbol d' to denote an inexact differential should exclude the possibility of confusion between path functions and point functions (for which the unadorned d is used). The discussion of equations of state is illustrated by representations of the p-v-T surfaces for an ideal gas, for substances that contract or expand on freezing, for water and for helium and, with the help of such surfaces, the geometrical interpretation of the partial derivatives becomes at once apparent. The implications of the second law are made clearer by considering the alternative statements of this law due to Kelvin-Planck and to Clausius and its significance is more fully brought out from considerations based on transitions from ordered to disordered states of molecular energy.

The account of entropy is excellent and includes a discussion of availability and irreversibility. The opportunity is taken to indicate some of the more recent developments that have followed from the study of irreversible processes and non-equilibrium states. Onsager's important reciprocal relations are introduced and used to derive thermoelectric relationships from thermodynamic considerations rather than from the unjustifiable thermostatic arguments originally put forward by Kelvin.

Chapter 8 on Fluid Flow is welcome on account of the growing importance of the subject and the opportunity it affords of showing how problems in this field can be approached from the joint standpoint of thermodynamics and hydrodynamics. Consideration is given to both sub- and super-sonic flow and a useful section on shock waves is included. Following on this is a chapter in which the different processes whereby heat transfer is effected are outlined and in which some of the limitations of thermodynamics are pointed out.

The remainder of the text serves as a comprehensive introduction to the application of thermodynamics to various processes, to cycles and to reactive and non-reactive systems. Of special interest are the discussion of air conditioning in connection with single phase and two phase mixtures, the representation of the standard vapour power cycles on p-v, T-s and h-s diagrams and, in some cases, on p-v-T, s-p-T and h-s-p surfaces, the description of the mercury-steam heat engine, the treatment of internal combustion engines of the reciprocating, gas-turbine and jet propulsion types, and the analysis of refrigeration cycles and the heat pump. The large number of worked examples is noteworthy and the problems at the ends of the chapters are of real interest. The text is followed by a set of numerical tables relating to the thermodynamic properties of steam, air, mercury, refrigerants, etc., a selection of differentials extracted from a collection of thermodynamic formulas by Professor Bridgman and a note on systems of units.

The statistical aspects of thermodynamics are only briefly referred to. There is, for example, no mention of Nernst or what has come to be known as the third law of thermodynamics, but these are to be treated in a companion volume in course of preparation by the same authors. The present first instalment of the complete work provides what is, in every respect, a model text on the classical aspects of thermodynamics and one that can be unreservedly recommended not only to engineers but to physicists and chemists as well.

METALS FOR NON-METALLURGISTS

Engineering Metallurgy. By L. F. MONDOLFO and OTTO ZMESKAL. *McGraw-Hill Book Company, Incorporated,* 330 *West* 42*nd-street, New York* 36, *N.Y., U.S.A.* (7·50 dols.); and *McGraw-Hill Publishing Company, Limited,* 95 *Farringdon-street, London, E.C.*4. (56*s.* 6*d.*)

It would appear that in the United States engineering metallurgy, or metallurgical engineering, if not a recognised technology, does at least justify a course of lectures and an examination at the end of them. Messrs. H. K. Lewis and Company, Limited, the booksellers, list seven other publications with one or other of these titles of which four are by Americans, one is translated from the Dutch and two (one in preparation) are English. There are naturally other books, mostly English and of respectable antiquity, dealing with metallurgy for engineers; they are not, however, college text-books, being written primarily for the practising engineer who is specifically concerned with some form of metal working such as casting, welding or deep drawing. Those who had the privilege of studying at one of the older British universities may sometimes be bewildered by current American text-books. The fact that they differ from the British does not justify a hypercritical attitude towards them since it would seem—though perhaps the view is a superficial one—that Americans are more successful than ourselves at turning out technologists.

Of the present volume the publishers write "this unique treatment of the subject blends theory and practice in a simple, comprehensive style." The authors describe it as "a modern college text for the teaching of metallurgy to engineering students whose primary interest does not lie in the metallurgical field." It may be said at once that the book is not of value either to a metallurgist, or, one would think, to a practising engineer. Whether it will be of assistance to student engineers in this country is problematical; it depends on whether any technical college runs a course similar to those in America for which the authors write. One would expect a British technical college to cover in much greater detail one specific subject, such as casting or rolling, in which case the present volume is too superficial. It is, perhaps, a matter for regret that it is unlikely to be read by those student engineers whose careers will lie in other fields, since they could well profit from the wider view the authors present.

The last three chapters deal rather summarily with corrosion and protection, iron and ferrous alloys, and non-ferrous metals. The first twelve are equally divided into theoretical and practical, of which six are what may be called linked pairs. These are chapters 5 and 6 on casting principles and practice, 7 and 8 on plastic deformation and annealing (theoretical) and plastic working practice, and 9 and 10 on phase transformations in the solid state and heat treatment and annealing practice. They should be useful to a student engineer in giving him some background knowledge before spending a vacation in a foundry or an annealing shop.

There are three other practical chapters: the first on the extraction of metals; the eleventh on joining (mostly, in fact, on welding), and the twelfth on powder metallurgy. These are purely descriptive and should present no difficulty. The only danger in this sort of treatment is that it may lead to the assumption that the actual practice of these matters is simpler than in fact is the case. The other three chapters, 2, 3 and 4, are theoretical. Their titles are respectively, "Atoms and Crystals," "Equilibrium Diagrams" and "Structure and Properties of Alloys." The student engineer is likely to find these much harder going, in particular the first two. They would present little difficulty to a physical chemist and possibly the authors count on their engineering students remembering enough of this subject to get by. Alternatively they may regard it as the duty of individual lecturers to fill in all the obvious gaps. Be that as it may, even if he is able to interpret an equilibrium diagram and knows what the various lines on it are intended to show, it will not permit him to dispense with the services of a professional metallurgist.

Perhaps only a student can say whether the authors have achieved what they set out to do, namely to outline the theoretical and practical aspects of making the raw materials, such as castings, strip, tube and wire, which the young engineer is going to use in the course of his professional career. If they have done this he will be a better engineer in being able to appreciate the problems of his other professional colleagues. It is to be hoped that it will not lead him to underestimate what he owes to them; to the professional metallurgist or foundry manager. The book is produced in the exemplary manner one expects of this publisher.

SOME ASPECTS OF THE AMERICAN AIRCRAFT INDUSTRY

(4) TRENDS IN ENGINE AND PROPELLER MANUFACTURE

In the first and second of these articles on the American aircraft industry, we described the varied activities and some research and development trends as observed in the factories we visited. The third article was concerned with developments in materials and manufacturing processes, and machines in the aircraft firms. This, the fourth and final article, touches on some aspects of production in the engine and propeller firms visited.

STEPS TOWARDS AUTOMATION

Owing to the scale of production orders for the J 47 turbojet which powers two of the United States' most successful military aircraft—the North American Sabre F.86D interceptor and the Boeing B.47 bomber—the General Electric Company have found it justifiable to instal a highly mechanised assembly line at their main Evendale plant near Cincinnati, Ohio. They are, in fact, applying progressive steps towards automation. Up to date some 35,000 J 47 jets have been constructed, and limited production of these engines still continues at Evendale, together with a limited production of J 73 turbojets, a more powerful engine than the J 47 in the " 9,000 lb. plus " class. The intake area is changed by regrouping the accessories below the engine and a different combustion system is used—ten flame tubes in an annular casing instead of eight individual cases. Both types of engine are built on the same assembly line.

Components built in other parts of the plant or by outside contractors are brought into the assembly shops, through inspection, to the major and minor stores by hand conveyors. From here, a fully mechanised conveyor system is employed, the major store consisting of 67 belt-powered roller conveyors in tiers of four (Fig. 1). Major parts are transferred from the store conveyors to the sub-assembly lines by elevating transfer cars. Minor parts, suitably marked for identification and location, travel from store, past all the assembly lines, back to store on a continuous conveyor, and are used as required. The main assembly is carried out with the engine vertical, nose down; in the sub-assembly stage the front casing and accessories are assembled on a dolly which then passes on to the powered main assembly line, and the successive sub-assemblies—compressor, aft-frame and turbine, and combustion system—are added. At the end of the line the nearly-completed engine is transferred by a hoist on to a rail-mounted dolly, now in the horizontal position, and is thence loaded on to a hanging conveyor giving access on all sides for installing the final piping and wiring details.

STEEL STRIP STATOR BLADES

In the machine shops are numerous examples of steps on the road to automation, in the form of multiple machine-tool improvisations, automatic conveyorised plating processes, etc. The most interesting of General Electric's production processes is, probably the fabrication of compressor stator blades from steel strip, introduced some three years ago in place of precision-forged blades, resulting in a 55 per cent. cost saving and a 39 per cent. saving in material. In brief, these blades consist of aerofoil-section steel strip, cut, inserted into a baseplate, and brazed (Fig. 2). In Fig. 3 is shown the automatic dieing machine in which two reels of precision-formed strip steel are formed, punched and finally pressed together at the centre to form a complete base section. These base sections, together with the aerofoil, are then placed in fixtures on the rotating index table of a welding machine and the two pieces are automatically welded together, picked up from the table and deposited in a tray for fluxing and heat treatment in a furnace. They are then automatically fed to a series of grinding machines. After surface finishing is completed, the blades are fed by belt conveyor to a Magnaflux machine where they are visually inspected for flaws, and thence transferred mechanically to shipping boxes.

TURBO-COMPOUND ASSEMBLY

Whilst in the United Kingdom production of the larger piston engines is now carried out only on a small scale—on a replacement basis, in fact—in America both Pratt & Whitney Aircraft and the Curtiss-Wright Corporation are in large-scale production with the piston engines that still power the vast majority of commercial aircraft and which are likely to continue to do so for the next five years or so.

Only two years ago Curtiss-Wright laid down an improved assembly line for the various versions of their 3,250-3,700 h.p. " turbo-compound " engines and their later developments—the power plants of the Douglas DC 7, Lockheed Super Constellations, the forthcoming very competitive Lockheed 1649 and a group of long-range high-performance military aircraft. Here, also, can be seen steps towards automation and the use of mechanised conveyors throughout the assembly lines. The improvements effected have reduced the total assembly floor area from 166,920 sq. ft. to 97,714 sq. ft., have cut sub-assembly times by 50 per cent., and have increased the finished-stores capacity by about 50 per cent., by the use of stackable bins and pallets, without any change of stores floor area.

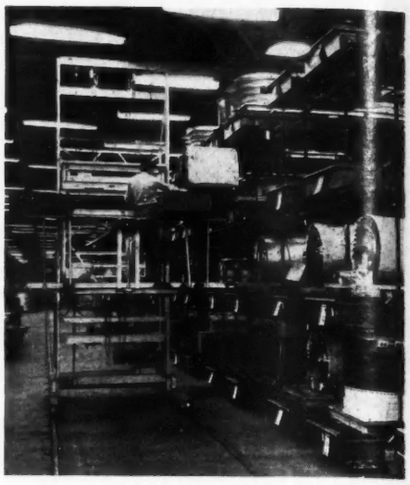


Fig. 1 At General Electric's Evendale jet-engine assembly plant, major parts are stored on 67 belt-driven roller conveyors. They are transferred from store to sub-assembly lines by an elevating transfer car.

Automatic bolt-tightening machines operating to a pre-determined torque are widely used throughout the assembly shop; in Fig. 4 can be seen a machine which tightens the bolts attaching the reduction gear pinions to the carrier ring, and crimps the fasteners securing them. Another automatic process is the locking of the valve springs into place in each cylinder and resetting them so that the rocker arms can be dropped into position.

The assembly process is, briefly, as follows: from finished stores to the point of use, parts move in pallets over roller conveyors. By the time the major portion of the turbo-compound engine has been built, floor conveyors are available to pull along the stands on which the engine is built up.

Such floor conveyors move the engine stands down both the pre-test assembly and final assembly lines, from there through a wash booth toward the production test-cells, then following the test, from a point near the test area through the packing room.

The assembly procedure throughout is planned

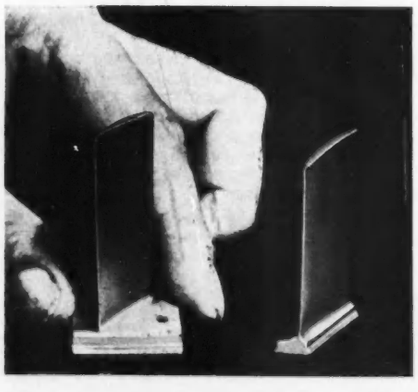


Fig. 2 Compressor stator blades of General Electric's J 47 and J 73 turbojets are formed from aerofoil-section steel strip, cut, inserted into a baseplate, and brazed.

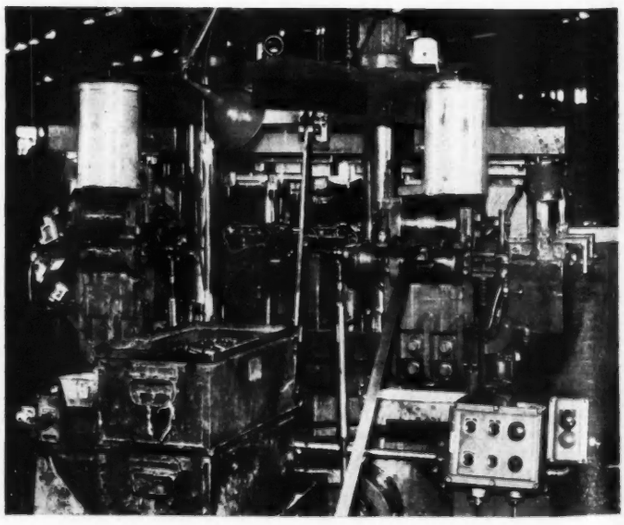


Fig. 3 The blade baseplates are formed in this automatic dieing machine from two reels of precision-formed strip steel.

Fig. 4 In assembling Curtiss-Wright turbo-compound piston engines, automatic bolt tightening machines are used for attaching the reduction gear pinions to the carrier ring.

so that turbo-compound engines are built up in three major sub-assemblies—the power section, the front section, and the rear section. Each of these units, when complete, is mounted on a flow rig so that a pre-check can be made to determine whether working parts move freely and whether all oil and fuel lines and oil-tight passages are clear and perform properly. Thus, each major sub-assembly is examined for quality and precision before the turbo-compound is completed.

There is one final stop between the time an engine is finished and the time it reaches production test. This is on a "pre-oil" rig that pumps in lubricating oil at engine-operating temperatures and pressures to ensure that all connections are tight. The rig is also capable of measuring friction at various places in the engine as the propeller shaft is rotated by the pre-oil machine.

In production test, assembled turbo-compounds are run for 4½ hours under the varying conditions that will be met in flight.

Following test, each new turbo-compound is fully dismantled, washed and inspected after which it is reassembled on the final assembly line. The ultimate proving of every engine is another test run, lasting this time 3½ hours.

HORIZONTAL BROACHING MACHINE

In the Pratt & Whitney Aircraft gas-turbine shops, they are particularly proud of their large horizontal broaching machine (Fig. 5) designed for them by the Lapointe Machine and Tool Company, Wisconsin, for slot-broaching turbine and compressor discs to receive the blades. The machine, which is electrically driven, is 30 ft. long and will take cutters up to 130 in. Although it occupies more floor space, it does not require the heavy foundations necessary for the older vertical hydraulic broachers—which are still in use—and it is more adaptable and faster in action. Whereas in the vertical machines the whole tool has to be replaced when wear occurs on any one tooth, in the horizontal machine, which can employ a wider tooth spacing, individual teeth can be replaced as required.

An inspection technique that has been adopted by Pratt & Whitney Aircraft with substantial time savings is the use of air gauging for checking turbine blades for convexity and concavity, tilt and thickness. Illustrated in Fig. 6 is an 18-tube air gauging machine, made by the Sheffield Corporation, Dayton, Ohio, which has made it possible to carry out a complete check in about two seconds. Hitherto, such a check carried out by "guillotine" and feeler-gauge techniques would have occupied about two hours.

When Orenda Engines Limited (then part of the original Avro Canada company) moved into their new factory in 1952, they were employing less than 200 direct production workers and had produced a total of 30 Orenda engines at their pilot plant—barely 10 per cent. of their planned production peak, but sufficient to provide useful guidance in laying out their new shops and techniques for the maximum flexibility, to allow for the ready incorporation of design changes in the production processes, and for indicating the directions in which production development must proceed in order to reach the desired target set by the Royal Canadian Air Force.

Today, Orenda have a total work-force of 5,500, including 1,500 engineering and experimental staff, and they have produced more than 2,500 engines—a notable achievement when it is remembered that the company started from scratch less than 10 years ago, and that the Orenda is the first jet engine to be constructed in Canada, thus posing exceptional problems of materials and parts supplies and, indeed, necessitating the establishment in Canada of a whole new range of sub-contracting industries, with their own problems of staffing to solve.

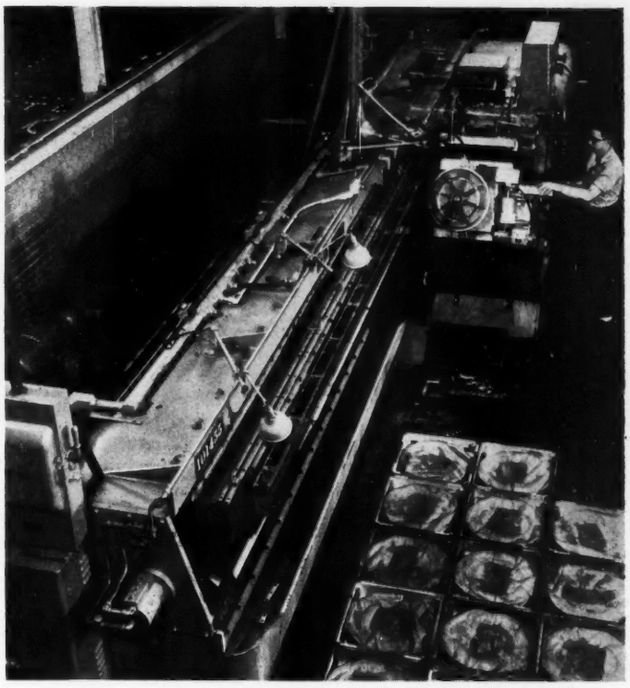


Fig. 5 Turbine and compressor discs of Pratt & Whitney Aircraft gas turbines are slotted to receive the blades in a 30 ft. horizontal broaching machine.

SPEEDING CUTTING PROCESSES

To build up production to the required rate involved two major decisions regarding production techniques—the replacement wherever possible of castings and forgings, which were in short supply, by sheet steel components, and the need for developing speedier cutting processes for the heat-resistant stainless steel components such as turbine rotor discs. Carbon dioxide coolants in conjunction with carbide-tipped cutting tools resulted in great improvements in cutting speeds and tool life, but a still more effective and less costly process has now been adopted—"Aero Mist Spray" cooling, in which lubricant and coolant are atomised, by means of the normal shop compressed-air supplies, and are blown through a nozzle to the tool point. (Fig. 7.) The cooling action is threefold—firstly by expansion as the fluid leaves the delivery nozzle under high pressure; secondly, vaporisation of the water content of the coolant by the heat generated by the cutting tool, and thirdly, instantaneous removal of the heat by the compressed air stream. The process has resulted in greatly increased cutting speeds, lower coolant costs, less swarf and better surface finish.

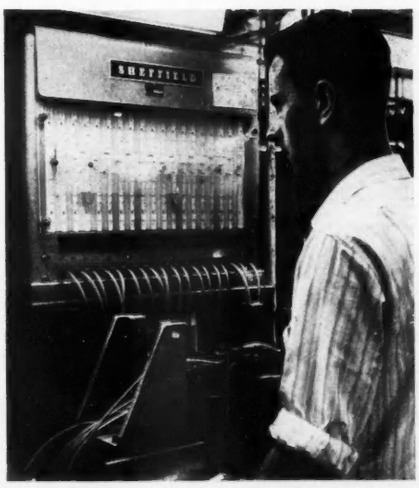


Fig. 6 Air gauging has substantially reduced blade inspection time at Pratt & Whitney Aircraft. On this 18-tube machine a complete contour and dimensional check can be carried out in two seconds.

BRAZING HIGH-TEMPERATURE STEEL SHEET

A typical example of the use of sheet steel where a machined casting was formerly employed is the nozzle box—required to withstand a temperature of the order of 1,800 deg. F. A new brazing technique is employed for fabricating the nozzle guide vanes; the brazing alloy known as Nicrobraz, by the Wall Colmonoy Corporation, Detroit, has a nickel-chromium-boron base, and a melting point of 1,950 deg. F. The brazing operation is carried out in a hydrogen atmosphere within a closed and sand-sealed stainless steel bell (Fig. 8), the latter being placed in a high-temperature automatically-controlled furnace after a hydrogen purge to ensure that all air has been driven from the bell; when only pure hydrogen emerges through the seal, it is lit and the bell is lowered into the furnace. After the heating period the bell is removed from the furnace and hydrogen continues to flow through the bell until the temperature has dropped to 200 deg. F.

14-SPINDLE COPY MILLER

As already noted, the Orenda machine shop is designed for maximum flexibility, and except in the blade shop special-purpose tools are not widely employed. Between every pair of machines there is a 1,000 lb. swivelling hoist to facilitate handling. In the blade shop there are some interesting tools designed for the company to their own ideas. For machining the aerofoil section of rough-forged steel turbine blades, 14-spindle Tracermatic machines are used, in which 14 blades can be simultaneously machined, each operation involving only one pass of the cutting head, which travels longitudinally down the aerofoil section, stopping

Fig. 7 Cutting speeds and tool life have been improved at Orenda Engine works by adopting spray cooling. The lubricant and coolant are atomised by compressed air.

just short of the root platform. This machine, hydraulically operated, employs a tracing head following a master blade form and controlling the cutting head. The root-platform area, where it sweeps up into the aerofoil section, is machined on a conventional type of milling machine.

This machine was one of the earlier ideas of the company, and it is now backed up by six-spindle Cincinatti aerofoil mills, also of the copy-milling type. These machines employ circular cutters, forming circumferential cuts, and a travelling work-table, and are rather more versatile than the Tracermatic in which the cut is longitudinal and the table is stationary; they are, however, more costly and require more floor space.

To set the blades in the cutting machine, locating holes are employed, and compensating centring drills to provide these holes have been constructed for the company by Brown and Sharpe, Rhode Island. The blade is mounted in a universal cradle under the control of a measuring instrument, which allows the position of the blade to be corrected for variations in twist, thickness, profile, etc., to obtain the optimum setting for drilling the locating holes. By this means it is possible to utilise satisfactorily blades which would otherwise be outside the tolerable limits.

The most recent of the plants visited was that of the Hamilton Standard Division of United Aircraft Corporation, Windsor Locks, into which they moved only three years ago. Occupying a site of 350 acres, the plant has been designed for flexibility in production. Foreseeing that the demand for propellers will decline as turbo-jets come increasingly into use, Hamilton have since the war branched out into such fields as cabin air-conditioning systems, pneumatic turbo-starters, electronic and hydromechanical fuel control units, high and low-speed aircraft hydraulic pumps, guided-missile power packs, etc., and they expect to diversify their products still more as need arises. Entering fields new to Hamilton in competition against well-established firms has rendered the cutting of production costs of prime importance. Production techniques are therefore under constant examination for possible improvements; hence the need for flexibility in the plant layout.

INDUSTRIAL WASTE

The plant is of one-storey construction, 1,000 ft. long and 600 ft. wide, attached directly to a two-storey office building, and it can readily be expanded. Electricity, steam, compressed air, ventilating air and cooling water are distributed throughout the factory on an overhead grid system. It has its own industrial waste building in which contaminated water from the factory is processed—8 to 10 million gallons a month are treated to remove metals and chemicals which might be harmful to plant and animal life. Chemicals and acids are neutralised in mixing tanks using lime, chlorine, etc., after which the water flows to a circular clarifier where the metals and chemical solids are separated and discharged to a sludge bed. All oils collected in the waste building are separated and recollected as a saleable by-product. Some 500 to 1,000 gallons of oil a month are thus salvaged. Appropriate solids collected from the sludge beds are used as fertiliser on the gardens in the factory grounds.

AUTOMATICALLY CONTROLLED SHEET GRINDER

Among many interesting processes and machines seen in the plant is an automatically controlled abrasive-belt machine for grinding the steel sheet used for the outer shell of the two-piece hollow-steel propeller blades, as shown in Fig. 9. A 60-grit belt coated with aluminium-oxide abrasive is used for roughing off the stock, the average sheet requiring 20 passes to remove 0·002 in. Formerly the sheet was put in one end, taken out the other end and moved around the machine to its original starting point. This procedure, repeated 20 times, required each sheet to be handled 40 times.

In the new machine—now in use for about a year—a photo-electric cell has been installed over the machine's weight-checking table and a counter mounted on the machine. A sheet is placed on the table, and the number of passes necessary to grind the sheet to size is determined. The counter is then set for the required number of passes and the sheet is started into the pinch rolls. The photo-cell reverses the pinch rolls after each pass, and when the counter has completed the cycle for which it was set, the sheet is automatically ejected on to the checking table.

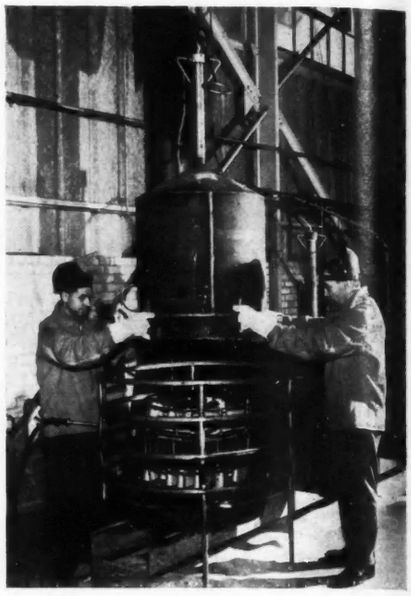


Fig. 8 Brazing of high-temperature sheet steel carried out by the Nicrobraz process in an atmosphere of hydrogen within a sealed stainless steel bell.

Since the sheet is started and finished at the same end of the machine, the personnel necessary for the operation has been reduced by 50 per cent. In using this reciprocating pinch-roll method, the sheet is ground both with and against the direction of travel of the abrasive belt. The amount of stock removed per pass is almost 50 per cent. greater than with the pinch-roll through-feed method in which the grinding is done with the " grain " of the belt.

We noted that many of the standard grinding machines using oil coolants or cutting compounds are protected from the hazards of oil mist formation by electrostatic precipitators; the oil mist is drawn off through ducts past a filter and deposited on a high-voltage screen, where the particles receive a positive charge. They are then attracted to negatively-charged collecting

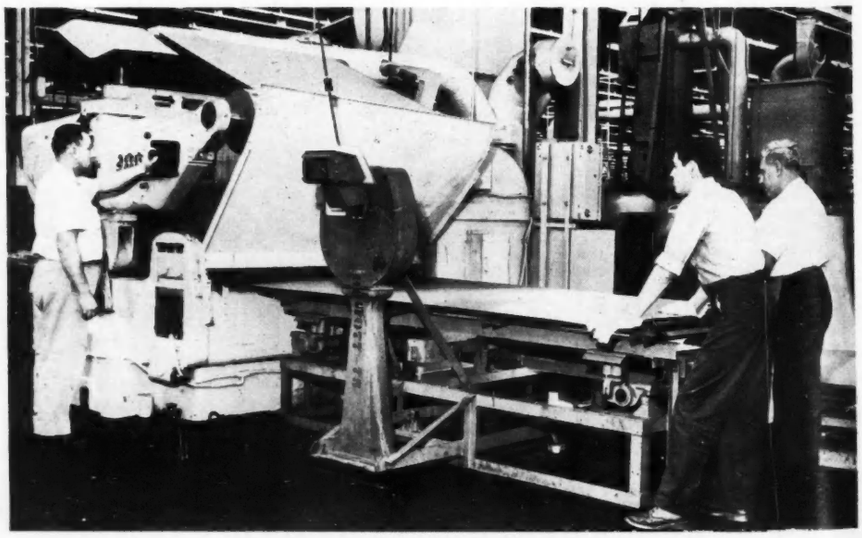


Fig. 9 Steel sheet for the outer shell of Hamilton-Standard hollow steel propeller blades is ground to the required thickness in an automatically-controlled abrasive belt machine.

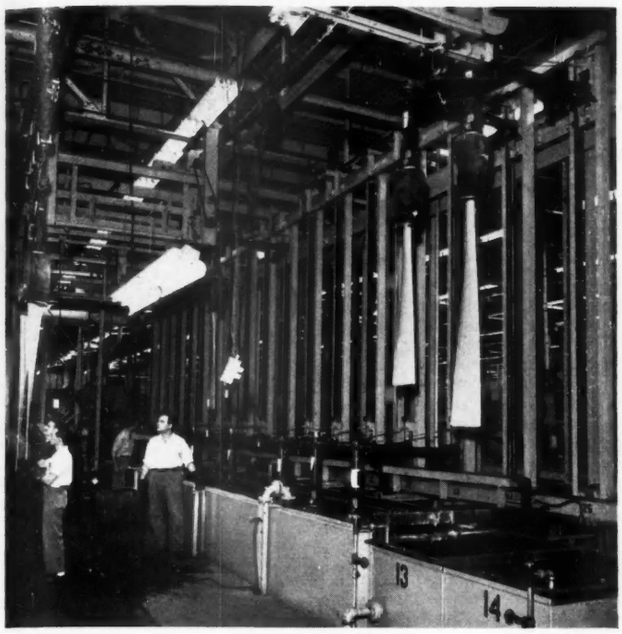


Fig. 10 Hamilton-Standard steel propeller blades are zinc plated in an automatically controlled plating machine which regulates the degree of plating to give the required blade weight for static balance.

wires where they accumulate and run down into collecting bags, thence to the machine sump.

AUTOMATIC ZINC PLATING

Also of interest is an automatic plating machine (Fig. 10) with a 10½ ft. vertical lift for zinc-plating steel propeller blades, an operation which serves for adjusting the balance of the blades as well as for corrosion protection.

The machine handles 12 blades at once in its main plating tank and has space for as many as 25 blades in various stages of its operation. The following operations are automatic: cleaning, rinsing, etching and plating; transferring to a mono-rail when re-cycling is required; transferring back to the plating machine after inspection, and by-passing any tank. In addition, a blade may be automatically delayed being set down in any tank.

The propeller blades are first fastened in a horizontal positioning device and lifted into place on the machine by an air-operated cable hoist with a specially designed hook. Suspended vertically from steel grips, the blades are moved through more than 15 cleaning, rinsing, plating and drying operations by an electrically-powered conveyor system. The blades travel an elliptical course of about 160 ft. around the perimeter of the machine, passing through a series of cleaning, acid and rinse tanks before entering the main plating tank. There, a weighing counter "tells" the blades whether to continue on to the unloading station or to transfer automatically to a separate mono-rail system for inspection, scrubbing and further plating. It takes a blade 135 minutes to make a complete cycle on the machine; the blade's time on the machine may be increased to as much as 370 minutes when additional plating is required. Some blades need only one trip through the main plating tank, while others require as many as six.

The other three articles in this series appeared on page 787, *December* 9; *page* 819, *December* 16; *and page* 851, *December* 23.

THAMES STEAM TUG CONVERTED TO DIESEL POWER

60-*Year-old Britannia Modernised*

An interesting conversion from steam to Diesel propulsion has recently been carried out on the Thames by the Greenhithe Engineering Works, on behalf of the Greenhithe Lighterage Company, Limited, with the installation of a National 350 b.h.p. engine in the tug Britannia in place of a compound steam engine and boiler which had served the vessel satisfactorily, though maybe not very economically, during her years on the river.

This vessel, 74 ft. long, with a 16 ft. beam and 10 ft. draught aft, was built by Watsons, of Gainsborough, in 1893 and fitted with engines by Edward Young, Millwall. In recent years, up to 1953, she was operated by the South Eastern Gas Board as the T. B. Heathorn; she was acquired in that year by the Greenhithe Lighterage Company, Limited, with the intention of converting her at a convenient time into a modern Diesel tug. The excellent condition of her hull gives promise that it is good for many years of service.

In carrying out the conversion, full advantage has been taken of the space previously occupied by the steam machinery, the result being a spacious engine-room with ample room for routine maintenance work. A daily service fuel tank and the header tank for the closed-circuit fresh-water cooling system are installed above the engine. Three storage fuel tanks, one athwartships forward of the main engine and two port and starboard abreast of the reverse reduction gears, have a total capacity of 9½ tons. An air receiver of 23 cub. ft. capacity is fitted in a vertical position in the forward end of the engine-room on the port side.

The new engine, built by the National Gas and Oil Engine Company, Limited, Ashton-under-Lyme, and supplied by Associated British Oil Engines (Marine), Limited (both members of the Brush Group), is an R4AM7 naturally-aspirated seven-cylinder engine developing 350 b.h.p. at 600 r.p.m. The drive is through a 3 to 1 M.W.D. oil-operated reverse reduction gear, giving 329 s.h.p. at 200 r.p.m. at the propeller. The drive between the engine and gearbox is through a pin-and-bush type flexible coupling, and the engine is fitted with a Holset anti-vibration damper on the end of the crankshaft.

The engine, of the four-cycle solid-injection type with a cylinder bore of 9 in. and piston stroke of 12 in., is of cast-iron construction with water-cooled main bearings, making the use of a separate oil cooler unnecessary. The top half crankcase forms the cylinder housing in which the separate cast-iron wet liners are inserted and secured by the cylinder heads. These cylinder heads are of the four-valve type, with two exhaust and two inlet valves symmetrically disposed around a central atomiser and fitted with heavy-duty cast-iron valve seat inserts. The arrangement provides ample cooling around the atomiser, allows a good heat transfer and prevents distortion arising from the heat stresses due to the passage of the high-temperature exhaust gases.

The pistons are of close-grained cast iron, and have four pressure rings and two oil-control rings with a gudgeon pin of the fully floating type working in a bronze bush in the top of the connecting rod, which is drilled for lubrication of this bearing from the pressure system.

The crankshaft is a solid forging of 40-50 tons carbon steel, oil hardened and tempered. In common with all the scantlings of the engine its dimensions are in excess of Lloyd's requirements.

The camshaft is gear driven from the after end of the crankshaft. The individual C.A.V. fuel pumps are mounted on a "keyboard" enclosed by easily-removable covers secured by knurled nuts. The governor is driven from the forward end of the camshaft by a gear train and, like the control gear, is situated on the port side.

The engine is fresh-water cooled on a closed-circuit system incorporating a heat exchanger. Both fresh-water and salt-water pumps are of the centrifugal type, gear driven from a spiral-bevel wheel on the forward end of the crankshaft. The gear-type lubricating-oil pump is also driven from this bevel wheel.

High water-temperature and low oil-pressure alarms are fitted, the latter being so arranged in conjunction with a low oil-pressure automatic shut-down that the alarm operates in advance of the shut-down device.

The gearbox is of the usual S.L.M. oil-operated type, and has its own lubricating oil pump and oil cooler which is supplied with cooling water from the engine salt-water circuit.

A Williams and James air compressor of 4·3 cub. ft. per minute at 350 lb. per square inch is belt driven with a clutch pulley from a forward extension on the crankshaft. An auxiliary compressor and a Megator pump are belt driven from a 5 h.p. Diesel engine.

On trial in Long Reach a mean speed of 10 knots was obtained with the engine turning at 600 r.p.m.; the exhaust temperatures indicated that the engine was very moderately loaded. Subsequently, static pull tests were carried out off the jetty; a pull of 5·375 tons was recorded with the engine at full torque, the maximum exhaust temperature being 815 deg. F. The exhaust is stated to have been quite clear at all speeds and there was a noticeable absence of vibration both in the engine room and on deck.

The motor tug Britannia, built in 1893, on full-speed trials in Long Reach off Greenhithe. Her compound steam engine has been replaced by a modern Diesel engine.

WORM-GEAR LUBRICATION

EFFECT OF OIL VISCOSITY ON POWER LOSSES AND WEAR

By R. Tourret, B.SC.(ENG.), A.M.I.MECH.E., A.F.R.AE.S.

The mechanical performance of a lubricant for a spur gear is judged chiefly by power loss and anti-scuffing properties. It is well known that with pure hydrodynamic lubrication, the lower the viscosity the lower the frictional losses. However, with high loads the viscosity of the lubricant is not adequate to keep the rubbing surfaces separated and E.P. additives, compounding agents, etc., are incorporated to prevent or at least delay the scuffing seizure which would otherwise occur.

The mechanical performance of a worm-gear lubricant is also judged chiefly by two criteria, first the power losses within the gearbox and second the rate of wear and amount of pitting of the bronze worm-wheel. Both of these have now been shown to be affected by the lubricant and in a manner largely different from that of lubricants used for spur gears. It is the purpose of this article to describe briefly what these effects are and how they were discovered.

Power losses have been studied both in small industrial worm-gear units and in the worm-gear back axles of a heavy lorry. In each case, under steady running conditions, losses arose from both churning and friction, which manifested themselves as heat, with the result that oil temperatures increased until an equilibrium was established between this heat input and the rate of heat dissipation due to cooling (from conduction, convection and radiation). Thus for given operating conditions, the lower the equilibrium temperature, the smaller the power loss within the gearbox or axle.

INDUSTRIAL WORM-GEAR UNITS

To investigate the relation between power losses and oil viscosity and to determine the relative importance of churning and friction under different operating conditions, two industrial worm-gear units, of different sizes, were installed.

One unit had a 3 in. worm/worm-wheel centre distance and a 10 : 1 reduction ratio, while the other had a $1\frac{1}{8}$ in. worm/worm-wheel centre distance and a 50 : 1 reduction ratio. Both were driven by electric motors through belts, power being measured and absorbed by simple brakes. Both units were assembled so that the worm was underneath the worm-wheel, i.e., as an underslung worm. The quantity of oil used was $1\frac{3}{4}$ pints in the large unit and $\frac{1}{8}$ pint in the small unit, the oil level being slightly above the worm in both cases. The temperature of the oil was measured with a mercury-in-glass thermometer, the bulb of which was just below the worm.

The test procedure was to operate the unit under no load until the operating temperature reached an equilibrium value at which the rate of heat dissipation (i.e., power loss) was balanced by the rate of heat dissipation from the unit by conduction and convection. A load of approximately half the recommended maximum was then applied and the unit operated until the new equilibrium operating temperature was reached. Finally, the maximum recommended load was applied and the equilibrium operating temperature again determined. The increase in equilibrium operating temperature above the ambient temperature for the various loads was then deduced for each test oil.

Tests were performed on a series of straight mineral oils, derived from the same crude by the same refining process but of different viscosity grades. Tests were completed at two speeds, the load being adjusted in proportion so that approximately the same power was being transmitted through the gearbox. The results obtained from the smaller unit are shown in Fig. 1—similar results were obtained from the larger unit suggesting that the size of the unit did not materially affect the character of the results.

It can be seen from Fig. 1, in which the temperature rise of the oil in the $1\frac{1}{8}$ in. unit is plotted against viscosity for the three output loads and two speeds employed, that at low loads the low-viscosity oil gave the smallest temperature rise, whereas at high loads the low-viscosity oil gave the largest temperature rise. At low loads, the losses were apparently mainly due to churning and the low-viscosity oil naturally gave smaller churning losses than the high-viscosity oil. At high loads, friction losses predominated over churning losses, and the high-viscosity oil was then more effective in separating the mating surfaces and hence gave smaller friction losses than the low-viscosity oil.

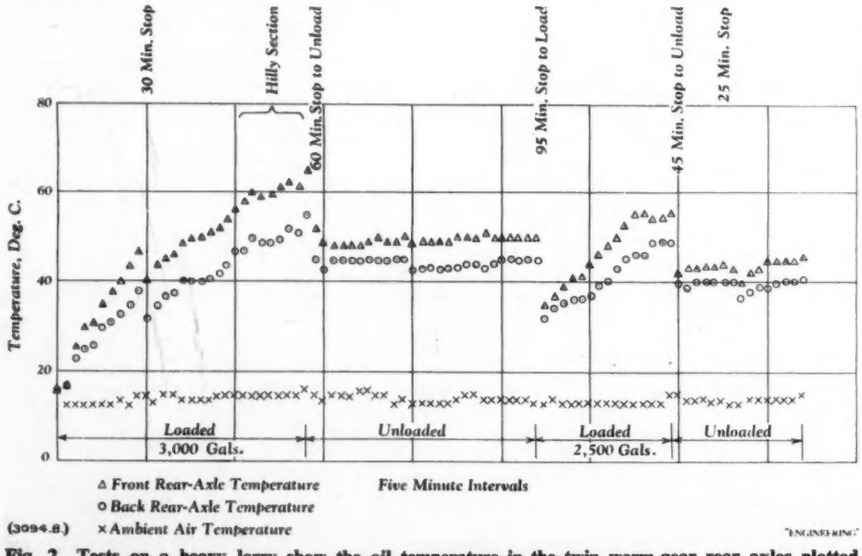


Fig. 2 Tests on a heavy lorry show the oil temperature in the twin worm-gear rear axles plotted against time. Stops were made to load and unload, and a number of similar tests were carried out using different oils.

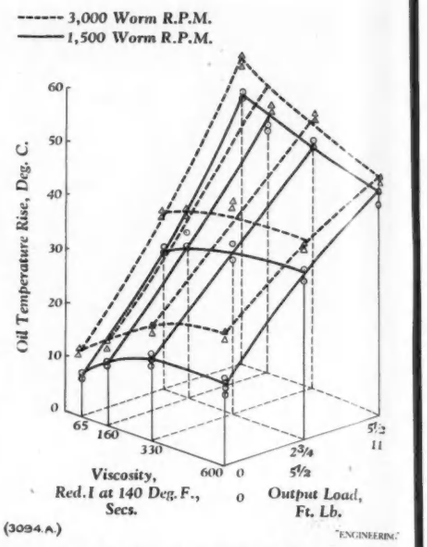


Fig. 1. Three-dimensional graph showing relationships between viscosity, output load, and oil temperature. Measurements were taken for two worm speeds, as indicated.

The effect of speed on the general trend of results was small although all the temperature rises were greater with the higher speed. The high-viscosity oil was most affected. At zero output load the loss was appreciably greater, obviously due to greater churning, whereas at full load the temperature rise was only slightly increased.

As would be expected, the effect of compounding the oil, i.e., adding a fatty component to combat friction, was to reduce the losses under high load without altering the no-load churning losses.

The results of some tests with different quantities of oil in the worm-gearbox indicated that this did not affect the equilibrium operating temperature. Although it would be expected that the frictional losses at high loads would have been insensitive to the quantity of oil, it was perhaps surprising that the churning losses at no load were equally insensitive. Possibly the extra churning with the larger amounts of oil was offset by the more efficient dissipation of heat.

AUTOMOTIVE BACK AXLES

Following the tests in the laboratory on industrial worm-gear units, field trials on the twin worm-gear rear axles of a heavy lorry were made to explore the effects of oil viscosity and compounding on power losses as determined from the equilibrium temperature rises.

The test vehicle was a dual-axle tanker delivering fuel oil from a depot in Liverpool to customers

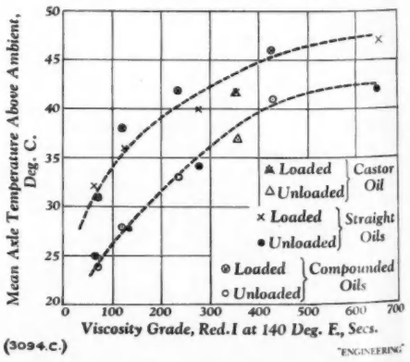


Fig. 3 Mean axle temperatures plotted against viscosity show an increase with increasing viscosity, although the axle temperature remains generally lower when the lorry is unladen.

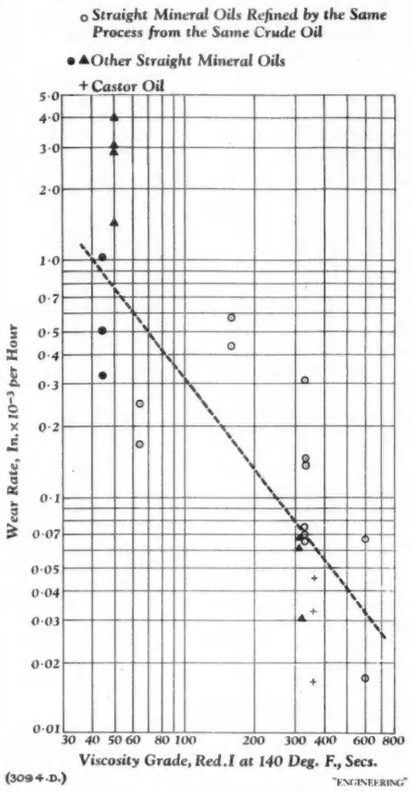

o Straight Mineral Oils Refined by the Same Process from the Same Crude Oil
●▲Other Straight Mineral Oils
+ Castor Oil
Wear Rate, In.×10⁻³ per Hour
Viscosity Grade, Red.I at 140 Deg. F., Secs.
(3094-D.)
"ENGINEERING"

Fig. 4 Wear rate of a bronze disc plotted against oil viscosity. Although the points are rather scattered there is a definite tendency towards decreased wear with increased viscosity.

situated at various places to the east of Liverpool, such as Manchester, Bolton, Bury, Warrington, and thus operating over fairly flat routes. This vehicle, which has been described elsewhere,[1] was found to weigh 9 tons 10 cwt. empty and 22 tons 5 cwt. when loaded with 3,000 gallons of fuel oil. The engine gave a nominal power output of 125-130 brake horse-power at 1,800 r.p.m. with a nominal maximum torque of 410 lb.-ft. at 900 r.p.m. The rear axle was of the overhead-worm type, the axle casing being a steel forging with a cast-aluminium worm housing. The differential was of the four-bevel type, the cage being carried in taper roller bearings. The worm centres were 9 in. and the reduction ratio 7·33 : 1. All the tyres used were of the same size and equally worn.

The instrumentation consisted of four thermocouples connected to a portable potentiometer carried in the cab of the vehicle. Thermocouples were placed in the oil in each of the two axles and in front of each axle. Thus the temperature of the air striking each axle was measured. In the event, the difference between the two air temperatures was negligible. The thermocouples and potentiometer were the only special instruments required. Vehicle mileage and speeds were obtained from the existing instruments. Tyre pressures were measured with a long-reach gauge specially reserved for this purpose. The vehicle was weighed in loaded and unloaded states at various weighbridges as opportunity offered.

The procedure for each test run was the same. At the depot in the morning, the tyre pressures, including even those of the less important front tyres were checked and, if necessary, adjusted to the recommended pressures of 85 lb. per square inch for the front tyres and inside rear tyres and 90 lb. per square inch for the outside rear tyres. The vehicle then started its daily deliveries, it having been impressed upon the drivers that they should drive the vehicle in their usual manner. Temperature readings were taken every five minutes; mileage, speed, route, weather, etc., being noted at the same time. When the vehicle finally returned to the depot, the tyre pressures were re-checked.

The oils used were a series of mineral oils, refined from the same crude oil by the same process but of different viscosities, tested both straight and compounded. Neat castor oil was also tested. Four separate tests of one day's duration each were carried out on each compounded oil and two on each straight oil and on the castor oil, the same oil being used in both the rear axles. The results obtained from a typical day's test run are shown in Fig. 2. In this particular instance, four equilibrium points were established, one for the vehicle loaded with 3,000 gallons, one with the vehicle loaded with 2,500 gallons, and two with the vehicle unloaded. The number of equilibrium points that might be established per day could not be predicted and varied in number from none to five or six depending on the nature and amount of delivery service performed on that day.

Over the range of viscosities tested, the average increase of axle oil temperature above ambient increased with viscosity for both compounded and straight oils, irrespective of whether the vehicle was loaded or empty (Fig. 3). The addition of the compounding agent did not affect the temperature increase, neither was there any indication that the performance of castor oil differed from that of the mineral oils. Since churning losses are chiefly dependent on viscosity, the higher the viscosity the greater the degree of churning. While friction losses would be reduced by compounding or by the use of neat castor oil instead of a mineral oil, the results indicated that the power losses were mainly due to churning and that the frictional component was negligible by comparison.

The question remains, however, of the extent to which the friction component of the power losses would become more important when vehicles are operated fully-loaded, or even overloaded, on mountainous routes. It may well be that a compounding agent would serve a useful purpose under such conditions.

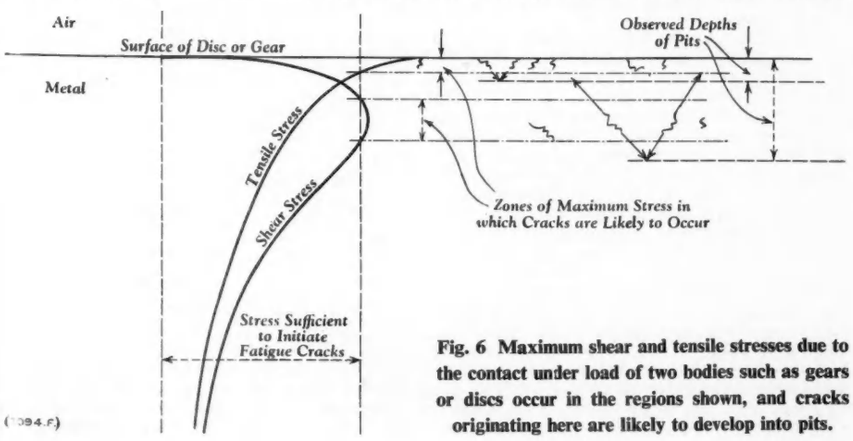


Fig. 6 Maximum shear and tensile stresses due to the contact under load of two bodies such as gears or discs occur in the regions shown, and cracks originating here are likely to develop into pits.

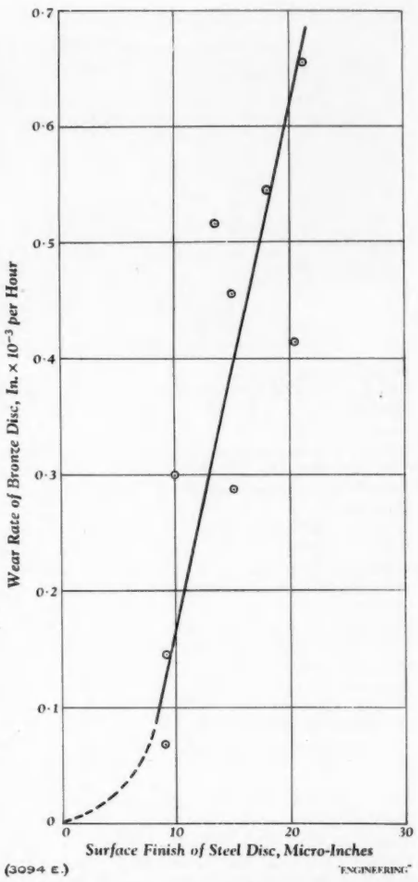


Fig. 5 The surface finish of the steel disc which bore on the bronze disc had a marked effect on the amount of wear; results of other tests showed that the curve might pass through the origin, as shown.

EXPERIMENTS ON WEAR AND PITTING

In general, it seems that metal of a worm gear is removed in one of two ways:—

(*a*) wear, in which minute particles are continually removed, the surface remaining reasonably smooth;

(*b*) pitting, in which comparatively large granules are removed intermittently, leaving distinct pits, to the detriment of the surface.

During wear, the rate at which metal is removed is very small and the surfaces remain smooth, but during pitting the amount of metal removed is much greater and the surface deteriorates.

Wear and pitting phenomena have been studied in a disc wear machine[2]. This employed discs as test specimens which were operated in loaded peripheral contact, speed, direction of rotation and diameter being chosen to give the combination of sliding and rolling experienced in service. To simulate the conditions existing in worm-gears, namely high sliding speed and surfaces moving in opposite directions, a 2 in. diameter steel and a 4 in. diameter phosphor-bronze disc were operated together coupled by a 1 : 1 ratio chain and sprocket drive. One disc was mounted on a shaft revolving in self-aligning bearings which were mounted in freely-swinging housings so that the disc maintained an even contact under load.

The order of magnitude of the coefficients of friction obtained indicated that the lubrication was of the mixed hydrodynamic/boundary type and not purely boundary as might have been expected from the high load and opposing

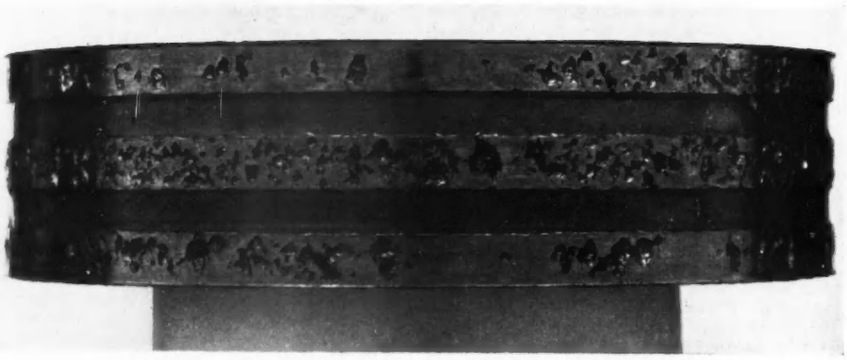


Fig. 7 A bronze disc operated for longer than usual to accumulate a collection of pits for study. The pits were found to be of two depth categories, 0·012 to 0·017 in. and 0·006 in., consistent with Fig. 6.

direction of motion of the contacting surfaces. The fact that the algebraic sum of the surface velocities was not zero would encourage some hydrodynamic action.

Wear and time-to-pitting tests were performed together, the test usually being concluded when the first pits occurred. The bronze disc was subjected to five hours running-in at the full test load prior to the initial measurement of the diameter with a micrometer—the final measurement of the diameter being taken at the end of the test. The running-in was regarded as the final stage in the preparation of the surface of the bronze disc for wear tests, but was included in the time-to-pitting results.

THE MECHANISM OF WEAR

The running-in process was considered to consist simply of metal-to-metal contact at isolated points which continued until the major asperities had been removed. When the wear-rate was high, as during running-in, the bronze disc formed a yellow track on the steel disc. This condition may be analogous to the scuffing encountered in steel/steel spur gears, since bronze wear particles had evidently been transferred to the steel disc, although no deterioration of the surface of the bronze disc was apparent and the discs continued to operate satisfactorily. The onset of the characteristic bronze discoloration appeared to depend solely on the wear rate. For instance, tracks usually appeared during running-in when the wear rate was high but disappeared later in the same test when the running-in was completed and the wear rate diminished.

When the running-in process was completed, most of the asperities would have been removed and the wear rate would decrease considerably, since the remaining asperities would generally be separated from the opposing surface by the oil film. The proportion of the load carried hydrodynamically would increase and the state of lubrication change from basically boundary to some mixed state of hydrodynamic/boundary. Running-in may be considered as having ended when the asperities became small enough for the lubricant to keep the discs generally out of contact. If the lubricant was unsuitable or the load excessive, "running-in" would continue indefinitely and the rate of wear would remain high.

It is the normal low wear-rate, after running-in had concluded, that will now be considered. The bronze surface was work-hardened by the repeated compressive and tensile deformation and so would become brittle. It was suggested[2] that very small particles would then be detached. If so, then the rate of wear would be low at first and later increase as the layer became more brittle. Eventually most of this surface "layer" would be removed, exposing a fresh ductile surface. The process may be repeated on the fresh surface which, however, would have already been work-hardened slightly by its proximity to the original layer, while remnants of the first work-hardened layer may also remain The new layer would therefore be work-hardened more rapidly than the first one. If the new process were continued the intervals between shedding surface layers would decrease and the separate stages merge until finally the surface would wear away simultaneously with the formation of fresh work-hardened layers below as a continuous process. This initial periodic variation in the wear-rate of bronze has actually been noted during the course of some special tests on the disc wear machine when the wear rate was determined during the test by using the scratch-and-Talysurf method of wear measurement[2] instead of being averaged over the whole test period as in the usual type of test. It has also been observed during other tests[2].

This tentative explanation of the mechanism of wear is consistent with wear being primarily a function of the fatigue properties of the surface of the bronze.

The viscosity of the lubricant might affect the pressure distribution with the result that the deformation of the discs or gears under load will be modified and the amount of work-hardening affected. Accordingly, tests were performed on a series of straight mineral oils of different viscosities refined by the same process from the same crude oil. The results (Fig. 4) showed that the wear rate depended to a considerable extent on the viscosity of the oil; an increase in viscosity from 100 to 600 seconds Red. 1 at 140 deg. F. gave a tenfold decrease in the wear rate from 0·3 to 0·03 in. $\times 10^{-3}$ per hour.

Test work was carried out using close limits of 5 to 10 micro-inches on the surface finish of the steel discs, the closest that could be maintained without an excessive number of rejects in manufacture. A short series of tests was undertaken to investigate the influence of finish on the wear rate of the bronze disc using slightly rougher steel discs. The results (Fig. 5) showed that the finish had a marked effect; the rougher the disc, the higher the rate of wear. The results of other tests, although not obtained under comparable conditions, suggested that the curve may pass through the origin as tentatively depicted. These results confirm the practical importance of having a fine surface finish on the steel worm in a bronze worm-gear unit or back axle.

PITTING

It has been shown[4] that the maximum shear stress due to the contact under load of two bodies such as gears or discs occurs below the surface (Fig. 6). It was suggested[5, 6] that this stress causes cracks in the interior which spread to the surface, resulting in the formation of a pit. It has also been suggested[7, 8] that the fluctuating tensile and compressive stresses caused by the normal and frictional components of the load and aggravated by the expansion caused by the high and rapidly-fluctuating surface flash temperature are responsible for work-hardening of the surface and hence for the formation of cracks originating in the surface, which also result in the formation of pits. Once a crack appears in the surface, whether it originates there or in the interior, it will fill with oil and the hydraulic forces exerted by the repeated application of load will propagate the crack until a pit is formed. It has been demonstrated experimentally[2, 9] that pitting occurs only in the presence of a lubricant.

A 4 in. disc was operated for a longer period than usual to accumulate a collection of pits for study (Fig. 7) and in particular to enable their depths to be measured. A convenient method was found to be focusing down the pits with a projection microscope. Pits were found to be of two depth categories, namely, deep pits ranging from 0·012 to 0·017 in. and shallow pits of about 0·006 in. This is consistent with pits having been formed from both internal and surface cracks as already indicated (Fig. 6) and suggests that whether internal or surface crack pits occur depends solely on the geometry and load between the contacting surfaces. In the particular case of the disc wear machine evidently both occurred.

The viscosity of an oil might be expected to affect its ability to enter a fatigue crack and propagate it to form a pit. Also, of course, the viscosity would affect the pressure distribution and hence the degree of work hardening. For both reasons, a high-viscosity oil would be expected to delay the onset of pitting. The

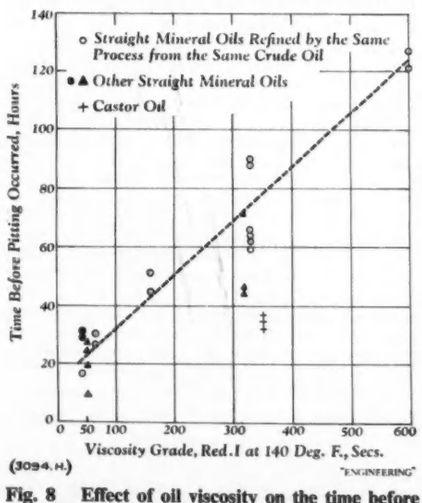

o Straight Mineral Oils Refined by the Same Process from the Same Crude Oil
• ▲ Other Straight Mineral Oils
+ Castor Oil
Time Before Pitting Occurred, Hours
Viscosity Grade, Red.1 at 140 Deg. F., Secs.
0 50 100 200 300 400 500 600
0 20 40 60 80 100 120 140
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Fig. 8 Effect of oil viscosity on the time before pitting occurred on a bronze disc. Increase in viscosity greatly delays the appearance of pits.

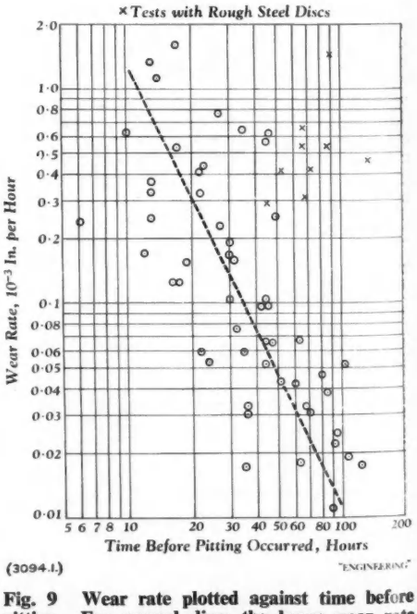
o Normal Tests
× Tests with Rough Steel Discs
Wear Rate, 10⁻³ In. per Hour
Time Before Pitting Occurred, Hours
2·0 1·0 0·8 0·6 0·5 0·4 0·3 0·2 0·1 0·08 0·06 0·05 0·04 0·03 0·02 0·01
5 6 7 8 10 20 30 40 50 60 80 100 200
(3094.I.)
"ENGINEERING"

Fig. 9 Wear rate plotted against time before pitting. For normal discs the lower wear rate goes with increased time before pitting occurs.

tests on a series of straight mineral oils already referred to showed (Fig. 8) that this was so; an increase in viscosity from 100 to 400 seconds Redwood 1 at 140 deg. F. gave a three-fold increase in time before pitting occurred from 30 hours to 90 hours. Castor oil gave an inferior result to that given by the equi-viscous straight mineral oils and it may be surmised that the free fatty acid content behaved like a chemical-type E.P. agent[8] and accelerated the onset of pitting.

The short series of tests already mentioned in which steel discs of varying surface finish were used indicated rather surprisingly that the surface finish of the steel disc had no marked effect on the time before pitting occurred, at least within the limited range of finish employed.

It is suggested that the type of steady wear, encountered in the disc wear machine test after the " abnormal " running-in period is over, is a function of the fatigue properties of the bronze, while there is little or no doubt that pitting is essentially a material fatigue phenomenon. That being so, some relationship between wear and pitting would be expected. On plotting results obtained from several different test programmes (Fig. 9) it is apparent that such a relationship does exist, the lower wear rates coinciding with the longer pitting lives. The only exceptions are the tests on rough steel discs performed to determine the influence of steel surface finish on bronze wear and pitting. These results would not be expected to conform to the general relationship since the wear rate was affected but not the time to pitting.

CONCLUSIONS

The general conclusion from the power loss measurements is that an oil should have low viscosity to give low power losses. It is an unfortunate paradox therefore that the general conclusion drawn from the wear and pitting tests is that a low viscosity oil aggravates both wear and pitting. As is often the case in engineering, a compromise must be reached between these conflicting demands. The best compromise for each case, however, will vary and can only be settled on its own merits.

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FULL-SCALE FATIGUE TESTS

DIESEL ENGINE CRANKSHAFTS AND PISTON RODS

Fifteen years of experiments on the fatigue endurance of Diesel engine parts were described in a paper presented to the Institute of Marine Engineers by Mr. P. E. Weine, M.Ing.F., of Burmeister and Wain, Copenhagen. Some of the experiments were carried out by the firm themselves and others by various Danish laboratories. The paper, the full title of which is " Full-Scale Fatigue Tests of Diesel Engine Elements," begins with notes on fatigue tests on small samples, notched rods, etc., subjected to rotary bending. The paper then proceeds with full-scale tests and some of the results of these tests are summarised below.

SPRINGS

The most important factor about spring material is probably that the surface is faultless, that decarburisation, scale and, above all, cracks are avoided, and that hardness is adequate. In the case of larger springs, however, surface polishing is difficult; and magnetic examination of all the springs is not only an expensive and difficult job to be undertaken only in exceptional circumstances, but also a purely negative measure, the best possible result of which can only be the discarding of all unsuitable springs.

Tests with shot-peening were carried out with actual springs (wire diameter 19/32 inch, coil diameter 3⅜ inch) in a simple testing machine in the firm's research department. Results showed it to be possible to increase the calculated torsional stress in the spring, for fracture at 10 million cycles, from 57,000 lb. per square inch, for ordinary spring wire to 85,000 lb. per square inch for correctly shot-peened springs. " Wet-peened" springs from another supplier were also tested. Their appearance was satisfactory but their fatigue strength was just the same as that of non-peened springs.

CRANKSHAFTS

On the pulsator machine of the Danish State Testing Laboratories, a series of tests was made with small crankshafts for truck Diesel engines. These had a crankpin diameter of 2⅛ in. and were of the type which is supported for every second cylinder only.

The tests were made with a full-size throw, the adjacent main bearings, and a section of straight shaft which took the place of the second throw so that the bending stresses in the throw being examined were similar to those in the actual shaft, disregarding the fact that the actual shaft is continuous. Interest was focused on the bending stresses, and the throw was therefore tested only in the position corresponding to the top dead centre, and with stresses corresponding to tension and compression forces of equal magnitude in the connecting rod, which comes quite close to actual conditions. This type of crankshaft has a rather unfavourable stress distribution because crankpin journal and main bearing journal overlap each other without borings. The material used was 5 per cent. nickel steel.

The shaft was first tested in its original form with 2 mm. (0·08 inch) fillets between webs and journal and then with 4 mm. (0·16 inch) fillets, which is the maximum attainable in practice on account of the surface pressure on the crank journal; with this an improvement of about 5 per cent. only was obtained. The fillet radius was then increased to 8 mm. (0·32 inch) at the expense of the web. It was not evident beforehand that this would result in an improvement, because the web was so thin that there was a considerable reduction in the moment of resistance; but it proved that the strength of the shaft increased by 35 per cent., possible due to the fact that the thickness of the web was reduced over such a length that it attained some flexibility and the stresses were better distributed. Most of the fully-forged and semi-built-up crankshafts produced by the author's firm are made according to this principle, which was introduced nearly 20 years ago, based at that time on theoretical considerations.

Tests were also carried out with holes in the journal and with a rather large eccentric hole drilled in the crankpin so that there should be the least possible material near the critical area, with a 3 mm. fillet; with these two designs also a 35 per cent. improvement was obtained compared with the original design. The deciding factor seems to be that the stresses are prevented from concentrating around the transition between journal and web, from which place the fractures most often start.

For an ordinary forged crankshaft a 35 per cent. improvement has thus been obtained by this method; but more can be obtained with cast crankshafts as the crank web can be made in such a way that the stresses are forced into the most remote part of the web; and by adopting quality cast iron of the Meehanite type, for example, the stresses can be reduced sufficiently to give the same margin of safety with a cast-iron shaft as with normal shafts of mild steel; at the same time a considerable saving in cost, of course, is obtained.

PISTON RODS FOR DOUBLE-ACTING ENGINES

These rods are of the type which pass through the crosshead and are secured by a nut on each side, and a series of tests was made on the pulsator machine of the Danish State Testing Laboratories; which can give a maximum loading of ± 10 tons. It was therefore necessary to limit the rod diameter to 36 mm. (about 1½ in.), the actual rods being 127 to 180 mm. (5 to 7 in.) in diameter. The experiments were started by tightening the rod so that the pre-tension between the nuts would be 14,200 lb. per square inch according to ordinary calculation methods; but it was noted that the rod broke in the " free-end " thread at a varying stress of ± 9,500 lb. per square inch measured at the piston end, which corresponds to approximately only ± 3,000 lb. per square inch at the free end. By means of a tensometer, the elongation of the part of the rod traversing the crosshead was checked, and it was seen that the pre-tension in reality was approximately 7,000 lb. per square inch.

When the test rod received the intended pre-tension, 14,200 lb. per square inch, it did not break until at ± 12,800 lb. per square inch at the piston end, but the fracture still occurred in the free end where the varying tensile stresses were hardly 4,000 lb. per square inch. It was also seen that the fracture did not start at the bottom of the thread but at the transition between thread-rounding and flank, and this is no doubt due to the fact that to the simple tensile stresses in the cross section must be added the bending stresses in the thread, to which, of course, the notch effect must also be taken into consideration.

Tests were made with various forms of thread and a considerable improvement was attained by increasing the axial height of the individual threads, or—as is the present practice—by reducing the radial height. In this way a fatigue strength of 15,000 lb. per square inch was obtained and the fracture now occurred at the uppermost thread at the piston end when the pre-tension was sufficient. However, special alloy nuts had to be used.

Tests were also made with rolled threads. This naturally called for some preparatory experiments to find a suitable degree of rolling, the correct flank angles on the roller, fillet radii, etc.; but the efforts produced as a result a fatigue strength of 21,000 lb. per square inch.

Within the same outer dimensions of piston rod and crosshead, the fatigue strength has thus been increased from 9,500 to 21,000 lb. per square inch or more than doubled, without making the design materially more expensive; the special alloyed steel for the nuts costs somewhat more than unalloyed steel, and the rolling of the threads is also expensive, but the price increase on the whole design is nevertheless minimal compared with the increase in strength by 120 per cent. To obtain a similar improvement by increasing the diameter of the piston rod by 40 to 50 per cent. would have required such great alterations of the engine design that it could not have been carried out in practice.

Tests with rods shrunk into the crosshead gave a fatigue strength practically the same as for the best design of threads and nuts, but without using rolled threads. Tests on the stress relieving of large welds were also made.

DISC BRAKES

THEIR APPLICATION TO MOTOR VEHICLES

In a paper presented to the Automobile Division of the Institution of Mechanical Engineers on November 8, Mr. F. J. Bradbury and Mr. F. G. Parnell reviewed the growth and present position of the disc brake as applied to motor vehicles. The main part of the paper was devoted to a consideration of those factors which control design, rigidity being of paramount importance if no external servo is used. Some brief extracts from the paper are given in this article. Both the authors are with the Lockheed Hydraulic Brake Company Limited.

Bearing in mind space limitations, the ability of a brake to dispose of the heat generated during application, or to withstand it without loss of efficiency, is a measure of achievement in design. Where space was not so restricted, the drum brake gave very satisfactory service, and will no doubt continue to do so as long as it is not overworked. The steady increase in maximum speed and acceleration of motor vehicles, however, is causing designers to consider a basically different alternative.

A disc brake was patented by Dr. F. Lanchester in 1902, but it is not known if it was ever incorporated in a vehicle. It consisted of a thin disc attached to the wheel hub and two small friction pads which clamped the disc between them by a pincer action. The first major application of disc brakes was on German trams during the 1914-18 war, and the A.C. car used them in 1925 or slightly earlier. A transmission disc brake (the Tru-Stop) was used on a commercial vehicle in America in 1928. This incorporated radial passages to give improved cooling and is still in use to-day, virtually unchanged. In Britain, Captain Eyston's Thunderbolt of 1937 was fitted with two disc brakes resembling clutches; the friction pads were fixed to both sides of the rotating member and were clamped between cast-iron plates. At the beginning of a stop at 180 m.p.h. the power absorbed was just under 1 h.p. per square inch of friction material. Aircraft designers during the 1939-45 war developed the disc brake for their purpose, and it was taken up to some extent in America. They have since been fitted to various racing cars with much success.

The disc brake is superior to the drum brake in its anti-fade properties, as the cooling is better, less distortion occurs, and the coefficient of friction does not decrease due to rise in temperature. The high rate of cooling is possible as the rubbing surfaces are in direct contact with the air. Another source of loss of efficiency with the drum brake is that when heated the radius of the shoe no longer corresponds with that of the drum, with consequent reduction in effective area and of self-energising. With a disc brake the loss is very much less as the self-energising factor is not affected. The stability of the drum brake has been improved by using special leading and trailing-shoe designs, but owing to the low brake factor and large lost motion, the use of an external servo is necessary. The disc brake also has a low brake factor, but its high rigidity enables high displacement ratios to be used, and satisfactory braking can be obtained on small and medium-sized passenger cars without an external servo.

BASIC FORMS

Considering the simple disc brake in which the disc is clamped between two sets of friction pads, there are three basic forms. These are: (1) axially-floating disc and fixed caliper; (2) fixed disc and axially-floating caliper; and (3) fixed disc and fixed caliper. The first is used in the majority of aircraft applications, the disc being keyed to the axle with freedom to move axially. It was discarded for vehicles owing to the cost and the backlash resulting from wear which gave rise to noise. It is, however, used in some racing cars. The second design is the logical opposite of the first, and likewise allows centring of the disc between the pads. It is claimed that there is a reduction in complexity of the hydraulic system since wheel cylinders are only required on the inboard side of the disc. The design has given good results during extensive testing. In the third design, it is necessary to have separate hydraulic cylinders on each side in order to equalise the load, or else to employ a special mechanism. Experience, however, has shown that the design is sound and it has been used successfully on passenger cars, commercial vehicles and racing cars.

MATERIALS

The material from which the disc is constructed should have (1) good heat conductivity; (2) high resistance to scoring and thermal crazing; (3) good mechanical strength; and (4) constant friction characteristics. Item (1) suggests the use of copper, but this is ruled out on account of cost and weight. Chromium-plated steel has proved satisfactory and so has chromium cast-iron, although this has a lower mechanical strength. In spite of the development of many materials, the choice at present remains between these two with the possible alternatives of spheroidal graphite iron and pearlitic malleable iron for special circumstances.

Since the 1939-45 war, the majority of disc brakes have been fitted to vehicles originally designed for the drum type and consequently the discs have assumed a "top-hat" or dish shape. Subsequent tests have shown that this is a good compromise shape as it gives a comparatively long heat path before reaching the bearing and therefore does not increase the temperature of the latter unduly. Moreover, cracking at the holes of the fixing studs due to distortion is not so likely. Various designs have been produced with the aim of improving the cooling, including the Tru-Stop mentioned earlier, and a later version in which the air ducts are cast in a solid disc instead of using two thin plates with a spider centre-piece.

The quality of the finish of the rubbing surfaces has a considerable influence on the rate of wear of the friction pads. Unless chromium plated, the surface should be turned and ground to a smoothness of 10 to 20 micro-inches. The flatness and squareness or "run out" in relation to the rotational axis should be as small as possible and not exceed 0·005 in. at the outer edge of the disc. The two surfaces should also be parallel within 0·001 in., measured as a thickness along the rubbing path.

Basically, the caliper is a load-carrying member which transmits the reaction from the direct and braking loads on the outboard friction pad to the brake backplate or adaptor. It is frequently necessary that a direct load of 4,000 lb. be applied to each side of the disc in a medium-sized passenger car. Deflection of the jaws under load increases the lost motion of the system and therefore great stiffness is required. Development work has shown that stiffnesses greater than 0·001 in. per 1,000 lb. are practicable with a load carrying member of steel or malleable iron and wheel cylinders of light alloy.

LOST MOTION

The relation between pedal load and the output of a brake is largely dependent on the overall displacement ratio, which may be defined as the ratio of the linear movement of the pedal to the average of the axial movements of the pistons of the wheel cylinders. It is therefore also equal to the product of the pedal ratio and the hydraulic area ratio. The available travel of the brake pedal is usually specified by the vehicle manufacturer, and it has been quoted as the most expensive ingredient to be built into a motor vehicle. Therefore it is used as a starting point for brake design. It can be shown that the total lost motion—made up from losses due to fluid compression, caliper and automatic adjuster, and in master cylinder, pipes, cups and hoses—is greatly increased by an increase in pedal ratio. This applies in particular to the losse sin the master cylinder. Any included air also causes lost motion. Since the clearance between the friction pads and the disc has considerable influence on the system design, it is essential that some form of automatic adjuster should be provided. In the "hydrostatic" type, a light pressure in the cylinders keeps the pads in contact with the disc. This has the disadvantage of causing some heating and increasing wear. Alternatively a positive retractor can be fitted which pulls the pads clear of the disc after each application of the brake. This method has proved very successful in practice.

One of the major problems associated with disc brakes is the provision of a satisfactory hand-brake system, which legally must be independent of the foot-brake system. The necessity for automatic adjustment renders a combined system difficult and the method of using a separate caliper on the rear disc is generally preferred for passenger cars. As the rate of wear of the pads is low, no automatic adjuster is needed.

The braking problems associated with commercial vehicles are no less difficult than those on passenger cars, and the application of disc brakes has not been neglected. There are indications that considerable weight saving is possible —as much as 69 lb. per vehicle has been quoted. In addition, a better braking performance is obtained, and maintenance costs should be reduced due to the necessity for fitting an automatic adjuster. It may, however, be necessary to use multiplate discs to supply the required force, and this leads to cooling problems.

PAD SHAPE AND POSITION

To obtain the best results with any brake it is necessary to use friction pads having the optimum shape and performance characteristics. The circular pads originally used are being superseded by segmental pads which show a better wear pattern. The actual area in contact with the disc varies according to the application, and is determined on the basis of horse-power absorption per square inch. A maximum value for this of 6 h.p. per square inch is normally recommended, but in certain installations this has been increased to 10. All friction materials at present available have critical values of rubbing pressure and temperature above which their rate of wear increases disproportionately.

As with many other components on the modern motor car, vehicle space limitations provide a major installation problem. This is made more difficult with a disc brake by the fact that there is an optimum position for the caliper in relation to the wheel bearings. To reduce the load on the bearings when the brake is applied, the caliper assembly may be positioned at the rear and on the horizontal centre line of the wheel bearings. Unfortunately this may produce alternating loads on the bearings and other undesirable characteristics. Practically all the disc brakes publicised in Britain since the war have employed exposed discs which appear to have operated satisfactorily. There is evidence, however, that in sandy or dusty conditions the rate of wear is considerably increased, and some protection may be needed in these cases. This, in turn, raises the question of adequate cooling.

When compared on a basis of equal size there is no doubt that the disc brake can provide a better performance than the drum. It must be realised, however, that at the present stage of development considerable superiority is only shown when the drum brake is overworked. It is therefore probable that the disc brake will be widely used first on the larger and faster vehicles and will be gradually adopted on the smaller classes as development proceeds. The position is more favourable for use on commercial vehicles as space is often less restricted, giving more scope in general design and better cooling. The trend toward a handbrake on the transmission will probably continue as this simplifies the installation problem.

REMOTE INDICATION OF LARGE DIRECT CURRENTS

METHOD FOR USE WITH GENERATORS

In modern power stations it is the common practice to locate the control room at some distance from the turbine room, or even in a separate building. In such cases it is essential for the operating engineers to be given accurate information regarding the machine conditions and, although this presents no serious problem where alternating-current indicating instruments and direct-current voltmeters are concerned, difficulties do arise when it is a question of measuring alternator field currents, which are normally in the range of 300 to 3,000 amperes. The arrangement usually employed for this purpose is to install a shunt near the alternator or exciter so as to reduce the heavy current cable to a minimum, and to run light gauge leads thence to the control toom. This may, however, give rise to substantial errors owing to the variations in the ambient temperature of these leads, which may be of considerable length, or to defects in the instrument circuits.

The British Thomson-Houston Company, Limited, Rugby, have therefore introduced the use of transductors or " direct-current " current transformers for metering field currents, and the system described below has been in use in a large British power station for the past three years. These current transformers, one of which is illustrated in Fig. 1, consist essentially of a magnetic system with two windings, one of which is connected in series with the circuit carrying the direct-current that is to be measured, and the other across a convenient low-voltage alternating-current supply at, say, 110 or 240 volts. The meter itself is placed in the latter circuit, the current in which is always proportional to that in the first winding.

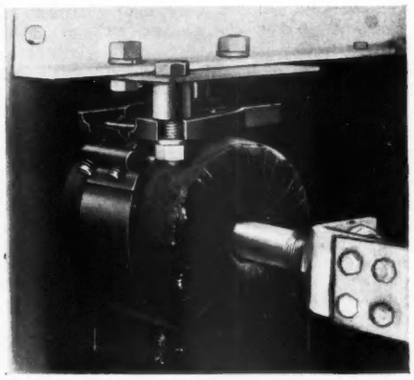

Fig. 1 By the use of a saturated core, the transductor can be made to give accurate remote indication of direct currents.

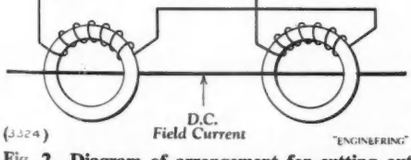

Fig. 2 Diagram of arrangement for cutting out alternate half cycles when the alternating current is not metered by the direct current.

PRINCIPLES OF OPERATION

The reasons for this proportionality are these. The direct-current winding is in series with the alternator rotor. As the circuit is highly inductive, a rapid change in the direct current is therefore prevented and, in fact, it can be regarded as constant. The effect produced by any current in the secondary alternating current winding is alternately to buck and boost the magneto-motive force produced by the steady direct-current. As the magnetic core of the transductor is highly saturated by the passage of the direct current alone, any additional magneto-motive force due to an instantaneous flow of current in the alternating-current winding in the same sense will produce a negligible additional flux and therefore no back electromotive force.

During the intervening half cycles, however, the current in the alternating current winding produces a magneto-motive force in the opposite sense to that produced by the direct-current winding. As the magnetic circuit is initially saturated by the direct current, the initial impedance offered to the alternating current is very low, but the value rises very steeply until the magneto-motive force is equal and opposite to that produced by the direct-current winding. At this point the core becomes demagnetised, a rapid change in flux occurs, and a high back electromotive force is induced, thus limiting any further increase of current in the alternating current winding. The effect is, therefore, to produce a square alternating-current wave, the value of which is limited to that determined by the direct current in the primary winding.

To cut out the alternate half cycles when the alternating current is not metered by the direct current, it is usual to connect two single-phase units in series opposition, so that the alternating-current flow is restricted to the correct value in every half-cycle by one or other of the two units while the other unit is idling, as shown in Fig. 2. As a result an alternating current of substantially rectangular wave form with a peak value proportional to the direct current flowing in the primary winding, is produced, and this can be measured either on an alternating-current or rectifier instrument.

TRANSDUCTOR DESIGN

The two transductor units may be wound on ring or rectangular cores, and can be two separate physical units or combined in a three-leg core. Usually the direct-current winding is a single turn.

The accuracy obtained depends largely on the magnetic characteristics of the core material; high accuracy necessitating special high permeability alloys. Ratio error in the case of field current measurement is usually specified as not to exceed 1 per cent., but better accuracy can be obtained if necessary. The error, within wide limits, is independent of the burden, as the impedance offered by the alternating-current winding swamps any other impedance in the circuit. Accuracy is therefore maintained over a metering range of from 25 to 125 per cent. of the rated current.

The arrangement is not affected by variations in either the impressed voltage or the frequency. The readings are therefore not liable to drift due to temperature variations or to other troubles which affect the conventional shunt and millivoltmeter arrangement of measuring direct current. A further advantage is that the exciter circuit, which is occasionally subject to high transient voltages, is completely insulated from the instrument circuits which are inherently vulnerable to faults of this type. The danger of heavy short-circuits in the control room and risk to personnel are therefore reduced.

The secondary current can either be measured directly by an alternating-current ammeter, or by a rectifier and direct-current moving coil instrument. With either arrangement additional instruments can be incorporated without affecting the accuracy. For installations of the type described above, an alternating-current ammeter is however preferable, as the normal range of field current can be arranged to come on the open part of the scale. The complete equipment is shown in Fig. 3.

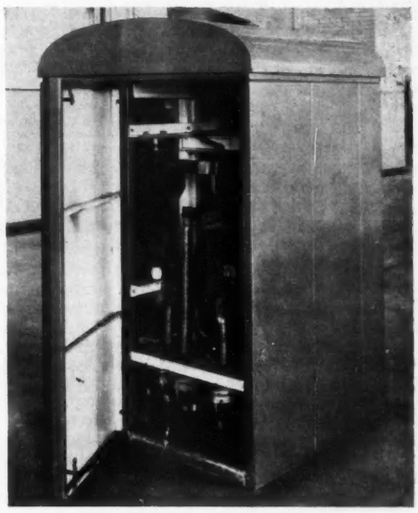

Fig. 3 Transductor for remote indication of current arranged in a field suppression cubicle.

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GYRATORY SEPARATOR

An improved version of the separator made by Russell Constructions Limited, 8 Adam-street, London, W.C.2, is the " Streamline " model. The screen area has been increased by about 23 per cent. giving almost double the output (1,000 to 30,000 galls. per hour). It is mounted on a box frame. Mechanical brushing gear can be fitted when large amounts of heavy reject material have to be handled.

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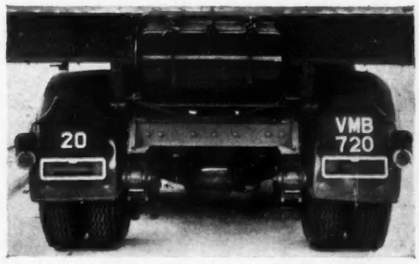
ANIMATED DIRECTION INDICATOR FOR ROAD VEHICLES

A new animated flashing direction arrow, which is designed to fit on the rear of commercial vehicles, has been introduced by Simms Motor Units Limited, East Finchley, London, N.2. This unit, which was displayed at the recent Scottish Motor Show, incorporates two translucent red arrows, directly in line with each other but of different lengths, as may be seen in the accompanying illustration. Electric lamps behind each arrow are switched on and off alternately, to produce the effect of a moving arrow.

The Simms' arrow indicator conveys the driver's intention to turn right or left quite unmistakably, and it is immediately apparent to other road users, not only by its shape but by the added illusion of movement.



The two arrows which form each indicator, light up in succession, giving the impression of movement.

The Iron and Steel Institute Autumn Meeting in London (*concluded from page* 863)

METALLOGRAPHY OF DELTA-FERRITE

The last technical session of the annual autumn general meeting of the Iron and Steel Institute, which took place in London on November 16 and 17, was held on the afternoon of Thursday, November 17.

The chair was occupied by the Hon. R. G. Lyttelton, past-President, and the whole of the session was devoted to the presentation and joint discussion of three papers by Mr. Kehsin Kuo who is at the Institute of Chemistry, University of Uppsala, Sweden. The papers constituted Part I, Parts II and III, and Parts IV and V of a contribution entitled " Metallography of Delta-Ferrite."

Part I dealt with " Eutectoid Decomposition of Delta-Ferrite " and the author stated that the δ-ferrite in a high-molybdenum steel which had been heated to 1,200-1,300 deg. C., had been found to decompose in a eutectoid manner within the temperature range 900-1,150 deg. C., giving austenite and the Fe_3Mo_3C carbide, called δ-eutectoid in the present investigation. Besides this eutectoid decomposition of δ-ferrite, two closely related reactions also occurred. As more austenite was formed from δ-ferrite, the austenite retained from high temperatures became unstable and later transformed allotropically into ferrite. At lower transformation temperatures a general precipitation of Mo_2C occurred in δ-ferrite, overlapping the δ-eutectoid transformation.

It was suggested that the slow diffusion of molybdenum was the controlling factor for these three internally connected transformations. It was expected that any alloy element which formed a special carbide and at the same time promoted the transformation of δ-ferrite—as did chromium, tungsten and vanadium—would make the formation of this δ-eutectoid possible, and this idea had been confirmed experimentally.

In Part II, entitled " Formation of Delta-Eutectoid in 18-4-1 type High-Speed Steels," the overheating, burning and solidification of high-speed steels of the 18 per cent. tungsten, 4 per cent. chromium and 1 per cent. vanadium type were correlated with the formation of δ-ferrite and its subsequent decomposition into austenite and the Fe_3W_3C carbide. The author stated that the 18-4-1 type of steel consisted of austenite and the carbide Fe_3W_3C at 1,300 deg. C. On further heating, δ-ferrite appeared first in low-carbon, and a liquid phase first in high-carbon steels. On cooling δ-ferrite decomposed into a troostite-like eutectoid of austenite plus carbide, which was often called the " dark-etching constituent." On slow cooling, this dark-etching constituent appeared, like the pearlite, with carbide lamellae in it.

Similar reactions were believed to occur also in other types of high-speed steel.

Part III bore the title " Isothermal Transformations of Delta-Ferrite in a Low-Carbon Cr-Ni-Mo Corrosion-Resistant Steel." Mr. Kuo stated that at 1,250 deg. C., a low-carbon 27 per cent. chromium, 5 per cent. nickel and 1·5 per cent. molybdenum steel contained only ferrite, which decomposed partially at lower temperatures into an aggregate of austenite and carbide. This aggregate had the typical appearance of lamellar pearlite when formed above 900 deg. C., and of acicular bainite when formed below 700 deg. C. Between 700 deg. and 900 deg. C., both types of structure were observed. The isothermal transformation diagram of this ferrite also resembled that of austenite in a hypo-eutectoid carbon steel.

Part IV was upon the " Decomposition of Delta-Ferrite between 650 deg. and 1,000 deg. C. in a Low-Carbon 18-10-3 Cr-Ni-Mo Corrosion-Resisting Steel." Mr. Kuo said that the decomposition of the steel under investigation, which contained 0·05 per cent. carbon, 17·5 per cent. chromium, 10·5 per cent. nickel and 2·8 per cent. molybdenum, had been studied by optical and electron-microscopic examinations. In the early stage of transformation acicular austenite, sometimes containing carbide particles, formed along certain crystallographic planes of δ-ferrite. This aggregate of austenite and the $(Cr, Fe, Mo)_{23}C_6$ carbide resembled bainite in appearance and appeared as grooves upon the polished surface.

The formation of the sigma phase occurred later and was mainly, if not entirely, in the δ-ferrite pools not yet transformed into austenite. Hence the sigma pattern was governed by that of austenite.

" Delta-Euctectoid and the Constitution Diagram of the Fe-' M '-C System " was the fifth and final part of Mr. Kuo's paper. He said that the eutectoid decomposition of δ-ferrite ($\delta \rightarrow \gamma +$ carbide) in vanadium, chromium, molybdenum and tungsten steels had been correlated with the constitution diagram of the various Fe-" M "-C systems. Vertical (constant " M " and carbon) sections had been used to illustrate the phase changes and horizontal (isothermal) sections to illustrate the reaction mechanism. This reaction had two special features; it was a binary (three-phase) reaction in a ternary system, and one of the components, carbon, moved much faster than the other two.

DISCUSSION

The chairman, the Hon. R. G. Lyttelton, said that the present work was part of a technical research programme sponsored by Jernkontoret, the Swedish Ironmasters' Association. Mr. Kuo was at the Institute of Chemistry of the University of Uppsala in Sweden, and during the time devoted to this investigation had been on leave of absence, from the University, at the Department of Metallography, Royal Institute of Technology, Stockholm.

Mr. T. H. Arnold, who opened the discussion, said that all workers concerned with this subject were under no illusions regarding the difficulties attendant on the positive identification of the micro-constituents present in highly-alloyed steels. Metallurgists could therefore pay tribute to the obviously thorough manner in which the microstructures had been analysed by the author and studied in order to extract every scrap of evidence likely to assist in their interpretation. He had nothing but admiration for the manner in which a mass of data had been presented and so lucidly and logically discussed, and he found himself inevitably in agreement with the author's conclusions. One point which might be mentioned, however, was that in the use of all these methods of examining the consituents he did not think that there had been any mention of the use of the magnetic etching method, described originally by Avery and others in *Metals and Alloys* in 1939. He had used this method ever since and had found it extremely useful in determining the difference between magnetic phases and non-magnetic phases in microstructures.

Dr. H. J. Goldschmidt said that in his Part IV the author had stated that the reason why chromium was the most ineffective element, compared with vanadium, molybdenum and tungsten, in modifying the iron-carbon diagram was still unknown. Was it not a fact, asked Dr. Goldschmidt, that it was relatively the weakest carbide-former, and was this not to be expected on many grounds, including the electron theory and the position of chromium in the periodic table, next to manganese?

Dr. B. Cina, among other points, referred to Part II, and dealt with the possibility of nitrogen pick-up. He said that as tungsten, as well as chromium and vanadium, had a strong affinity for nitrogen, the wisdom might be questioned of treating samples which were only 3 by 3 by 3 mm. in a nitrogen atmosphere at temperatures as high as 1,350 deg. C. It would be interesting to know the nitrogen content of the author's samples both before and after such treatment. Were the same metallographic features observed after treatment in an inert atmosphere such as argon as after treatment in nitrogen?

This question was pertinent to all five parts of the author's paper. The 8 per cent. molybdenum, the 18 per cent. tungsten, and the 27 per cent. and 18 per cent. chromium alloys would all readily form nitrides of these elements, and the absorption of such nitrogen at these high temperatures would alter the alloy balance and therefore the ratio of γ and δ formed at these elevated temperatures. In addition, the nitrogen might also become involved in the δ-eutectoid structure. The author's comments on this important issue would be welcome.

Occasionally in the discussion sections of certain of his papers the author had referred to the possibility of carbon for the δ-eutectoid being provided from the adjacent and original γ pools. Interpreting the decomposition of the δ-ferrite, insufficient attention seemed to have been given to this source of carbon.

Mr. Kehsin Kuo, in reply, said that he had not tried magnetic etching because he had not had any trouble in differentiating austenite from ferrite. With the reagents which he had used, the difference in tinge was very distinct, and the ferrite was darker in colour than the austenite. By using oxalic acid and very long etching times, he could almost always produce twins in the austenite. When, therefore, the austenite and ferrite grains were of a certain degree of fineness, there was no difficulty with them at all. If they were very small, the only method which he used was the relief effect. The ferrite stood out in greater relief than the austenite. He believed that the small magnetic particles would be too small for the magnetic method to be adopted.

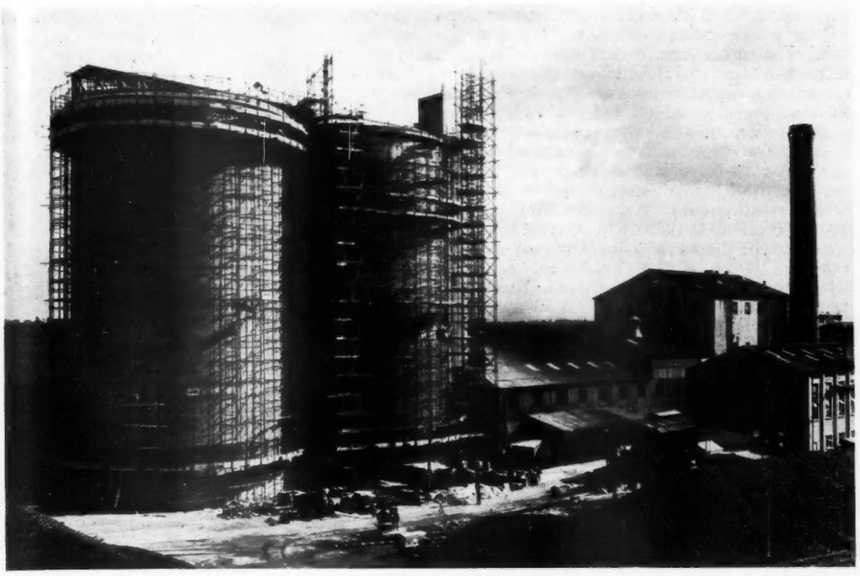
On the question of nitrogen pick-up, he had not done any work in an atmosphere such as argon or in a vacuum, so that he could not say how this transformation would behave in other atmospheres, and he had not determined the nitrogen content before and after heat treatment. All he could say was that the nitride of tungsten and molybdenum was not stable above about 800 deg. C., so that if there were any nitrogen pick-up it could not be due to the formation of nitride. In the case of chromium, however, there was considerable nitrogen pick-up in the standard steels, as had been found by many previous investigators. Hence he should, perhaps, have done something in connection with the study of these chromium steels, but he did not think that this kind of pick-up would affect the transformation very much in tungsten and molybdenum steels.

★ ★ ★

RECLAMATION OF BEARINGS BY WELDING

The large bearings contained in the driving-spindle universal joints of rolling mills and usually known as " slipper brasses " are bronze castings and may weigh up to 700 lb. When worn, attempts to reclaim them by building-up processes have often given rise to difficulties due to excessive distortion in the metal surface.

Quasi-Arc Limited, Bilston, Staffordshire, inform us that worn slipper brasses are now being built up efficiently by as much as $\frac{3}{8}$ in., with a minimum of distortion, by the adoption of their Sigma welding process. In this process an electric arc, shielded by inert gas, is employed, the electrode being in the form of bare wire. The inert gas employed for non-ferrous metals is argon and the aluminium-bronze wire used in this application is fed from a coil by an electronically-controlled motor to a welding gun held by the operator. A remote-control box enables the operator to adjust the speed of the wire feed during the metal deposition. Finally, the reclaimed bearing is finished by machinery.



The new prestressed-concrete silos constructed by John Laing and Sons for the British Sugar Corporation at Poppleton, Yorkshire. The roofs have steel frames supporting light-alloy cladding.

PRESTRESSED CONCRETE SILOS

NOVEL EXPEDIENTS FOR ECONOMIC CONSTRUCTION

Two sugar silos which, with a total capacity of 16,000 tons, are the largest in this country, have been built at the Poppleton, Yorkshire, factory of the British Sugar Corporation Limited. The large diameter of the silos and the method of construction presented a number of interesting problems in design and execution, as is described below. The silos represent a new advance in the storage of white sugar, which has hitherto been stored in 1 cwt. or 2 cwt. bags, piled high in warehouses. Formerly, each bag had to be manhandled on to a stack and manhandled off again when required for delivery.

The demand for pre-packed goods of all types has increased considerably since the war and this trend has in turn placed greater emphasis on methods of bulk handling. It soon became obvious that this was the case in regard to white sugar, and it was felt that the changed circumstances called for a method of handling which avoided bagging wherever possible, as has been secured with the new arrangements which have simultaneously enabled a marked reduction in the manpower employed.

The silos, shown in the illustration above, are 66 ft. in diameter by 100 ft. high from floor to roof. The silo floors are each pierced by 94 holes for discharge of the sugar and are mounted on columns 9 ft. 6 in. high, to provide a basement for conveyor machinery, giving a total height from base slab at ground level to roof of 120 ft. A conveyor bridge, 13 ft. wide by 18 ft. high, runs across the roof of the two silos and the accommodation for machinery is completed by a 13 ft. square elevator tower, 145 ft. high, constructed at one end upon the axis of the silos.

The whole structure is built in concrete, except for the silo roofs and conveyor bridge which are in structural steelwork, aluminium sprayed, and clad with lightweight materials of good thermal properties. The walls of the sugar containers are of prestressed concrete. The floor of the sugar containers and the whole of the basements and elevator tower are of reinforced concrete.

The foundations comprise 483 Franki piles, averaging 25 ft. long and capped by a 21 in. thick reinforced concrete base slab which carries 18 in. square columns at 8 ft. centres and 12 in. thick circular curtain walls. These walls were constructed in a single lift with a travelling shutter 20 ft. long mounted on rails.

The silo walls are of 8 in. thick prestressed concrete and the full height of the sugar was taken into account when calculating the horizontal thrust on the walls at the base. A small amount of mild-steel reinforcement was provided to take wind and other stresses during construction, vertical bending moments during stressing and temperature stresses in the walls.

Prestressing was accomplished by the Gifford-Udall system, using 0·276 in. diameter wires located outside the main walls and finally protected by coating with gunite concrete. Wires were tensioned in pairs from anchorages at opposite ends of a diameter and the anchorages were alternated between diameters at right angles to cause an even distribution of prestress. Small-diameter vertical mild-steel bars separated the stressing wires from the concrete to reduce friction during tensioning. Full-scale measurements of friction and other losses due to the curvature and anchorages were carried out, the spacing of wires being finally settled in the light of these test results.

The silo walls were constructed using sliding shutters lifted by hydraulic jacks, described below. The difficulty of maintaining a true circle on such a large diameter was successfully overcome by attaching the framework of the roof structure to the shuttering and raising them together. This also greatly simplified fixing of the roof.

The conveyor bridge in the roof, however, imposed an uneven loading and the measures taken to meet this on the first silo were not entirely satisfactory. On the second silo, jacks were used in tandem under the heavier loads with conspicuous success. Although the jacks were designed to lift in regular increments of $\frac{1}{2}$ in., special measures were necessary to check levels continuously and to apply corrections.

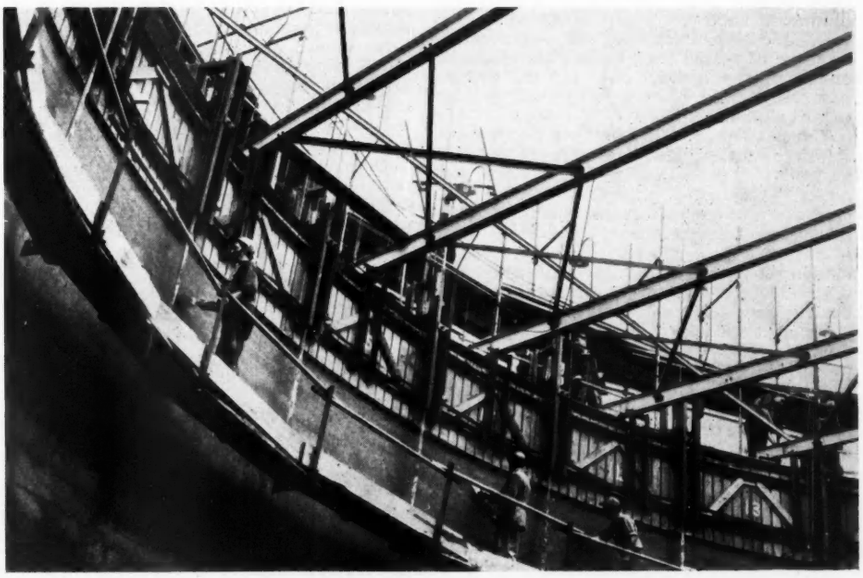
The concrete for the walls was specified to give a minimum cube strength of 5,000 lb. per square inch at 28 days and the rich mix which had to be used tended to give some difficulty with the sliding shuttering. This was overcome by a very rigid control of concrete consistency and the rate of climb.

Some difficulties were experienced during the construction of the first silo, but the experience gained made it possible to forestall them on the second, which rose steadily at an average rate of $9\frac{3}{4}$ in. per hour throughout the whole height.

The elevator tower was built by traditional methods using reinforced concrete. Walls are 8 in. thick and tied to the adjacent silo for stability. Intermediate floors were pre-cast to allow for easy modification of the machinery.

The first piles were driven in late February, 1955, and the civil-engineering work was completed in September, 1955—a total of 28 weeks—despite some delays occasioned by the dock strike. The designs were made in conjunction with the Central Drawing Office of the British Sugar Corporation, and the construction undertaken by John Laing and Son, Limited. The travelling sliding formwork was designed and its use was supervised by Mr. D. Parry, M.I.C.E., Lloyds Bank Buildings, Broadway, London, N.10.

The jacking system used to raise the sliding shutter is a new development by Tangyes, Limited, and had its first full-scale use here. The jacks were shown at the recent Engineering,



The silos are 66 ft. in diameter and a climbing shutter, shown here, was used during construction; the shutter was strengthened and maintained in true form by the final roof structure. The concrete was post-tensioned by external cables, afterwards gunited for protection.

Welding and Marine Exhibition and were described and illustrated on page 422 of our issue of September 23. At Poppleton, 40 jacks were spaced evenly around the circumference of the silo wall to support and raise the dead-weight and drag load of 80 tons.

The application of 1,000 lb. per square inch in oil pressure from a central pump causes the jack casing to ascend a climbing bar while the piston remains stationary. When pressure is released the piston also ascends the climbing bar under spring loading. Each stroke of the piston elevates the jack and shuttering a distance of 1 in. As the silo wall grows the climbing bars become part of the concrete reinforcement.

* * *

Three-ton mobile jib crane in slewed position for operation of grab. The chassis is fitted with four-wheel steering.

THREE-TON MOBILE CRANE

Robust Construction and High Efficiency

K. and L. Steelfounders and Engineers, Limited, Letchworth, Hertfordshire, have added another model to their range of Jones mobile cranes. In construction this is a smaller version of the firm's existing 6 ton crane and like it is built on the unit principle, the mechanism of each motion being designed as a totally enclosed interchangeable unit. As will be seen from the illustration above, it is mounted on a wheeled chassis which, like the superstructure frame, is of welded steel, bracing being used to ensure rigidity and to withstand the stresses produced while working or travelling over uneven ground.

The new crane is driven by a Petter two-cylinder Diesel engine with an output of 13·2 h.p. at 1,800 r.p.m. on the one hour rating; and power is transmitted through a friction plate clutch to a three-speed gearbox and thence to the main roller chain drive. This main drive is connected through separate clutches to each motion; of these the winch motion is a separate unit, smooth hoisting being ensured by a plate clutch. Sensitive control of the load, when lowering, is obtained by the use of a large brake drum on which two external shoes are pressed by springs. This drum is fitted with a pawl mechanism which engages the brake automatically as soon as the control lever of the clutch is released. The empty hook can be lowered at a speed of 160 ft. per minute. The hoisting speed with a 3 ton load on three falls of rope is 33 ft. per minute at 7 ft. 6 in. radius. The range of jibs includes one of the standard 20 ft. channel type in adition to those with lattices up to 40 ft. long. Swan-necks are also available as is a hydraulic cantilever jib 16 ft. 9 in. length.

SLEWING AND DERRICKING MOTIONS

The slew motion, which enables the superstructure to be rotated through a complete circle at a speed of 3½ r.p.m. is operated through friction plate clutches controlled by a lever in the cab. The superstructure itself is mounted on a large diameter ring of ball bearings, which are located in grooves, an arrangement which makes for smoothness in action and avoids high load concentration in the roller path and chassis frame. The superstructure is secured to the chassis by hook rollers, which operate on the underneath of the cast-steel slewing path and is held in position until the slew control is released by a friction brake. The derrick motion, which can be altered from maximum to minimum radius in 17 sec. is also a totally enclosed unit, which incorporates clutches and bevel and worm gearing. A brake is fitted to the worm shaft and is automatically applied when the lever in the cab is released.

MOUNTING ARRANGEMENTS

The crane is generally mounted on four "restrictor" wheels, which consist of two steel discs the diameters of which are slightly smaller than those of the pneumatic types. These wheels eliminate the risk of tipping, should a tyre become deflated. They also protect the side walls of the tyres from sharp materials and provide an increased bearing area on soft ground. The work can therefore be safely finished without damage to the tyre should a puncture occur. The crane can also, however, be mounted on a lorry, on rail wheels or on a fixed base. Power for travelling is transmitted through a flexible coupling to a totally enclosed gearbox whence it is led to the chassis through a vertical shaft. The direction of travel is determined by selector clutches, which are controlled by a lever on the steering column. Three alternative types of drive—direct, two-wheel differential and lock, and four-wheel differential—can be fitted. All four wheels are equipped with Girling shoe brakes, and for what it is claimed is the first time on a standard mobile-crane chassis, four-wheel steering is provided.

STANDARD CONTROLS

Generally speaking the controls follow standard automobile practice, but the steering is automatically corrected so that the direction is normal irrespective of the position of the superstructure on the chassis. This automatic correction is effected by a cam which runs on a path cast into the slewing ring and selects the appropriate gear in the reversing box. A chain drive and gear carries the steering motion to a Marles worm box on the chassis and thence to the wheels by the Ackerman system.

To ensure safe operation the crane is fitted with an indicator which shows the load which can be lifted safely in various positions of the jib. Overwinding of the jib is prevented by a limit switch. An automatic lock also prevents the winch lever being accidentally moved from the neutral position.

The crane will be marketed in this country by George Cohen, Sons and Company, Limited, Wood-lane, London, W.12.

TRANSPORT STAND FOR DART ENGINE

For Use with Fork Lift Truck

A transport stand for handling the Rolls-Royce Dart propeller turbine engine which powers the Vickers Viscount airliner has been developed by Morfax Limited, Willow-lane, Mitcham, Surrey, with the co-operation of Mr. C. B. Harrison of Rolls-Royce Limited, Derby. The stand, providing adequate protection for the engine, is suitable for both air and rail transport, and is specially designed for handling by fork truck as well as by the normal overhead lift. The all up weight of the stand and Dart power plant is approximately 2,000 lb. The accompanying illustration shows a Stacatruc effecting a rear-end lift of the complete unit at the Weybridge works of Vickers Armstrongs (Aircraft) Limited, who have about 30 on order.

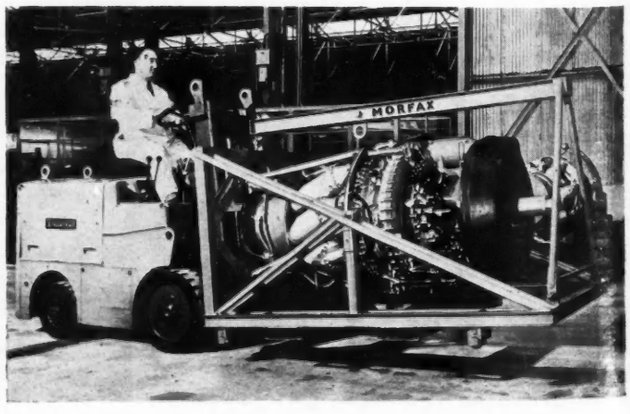
The power plant is cantilevered from the rear frame of the stand utilising the engine W-struts which pick up at four points. The port and starboard trunnion mounting points are secured between two hemispherical Duralumin cups, thus leaving the propeller shaft entirely clear. To ensure interchangeability of power plants, the cups and their mountings have been designed with an appreciable amount of axial and lateral adjustment.

The stand has been designed to carry either a complete power plant, ready for installation into an airframe, or a bare engine. When transporting the latter, the W-struts are not fitted and therefore the four pick-up points normally used in conjunction with these struts cannot be employed. Instead, a single V-strut is used which picks up the top trunnion ball on the engine and the top two mounting brackets on the rear frame. The side trunnion points are again used as when transporting a power plant. The V-strut is attached to the stand and can be readily removed when required.

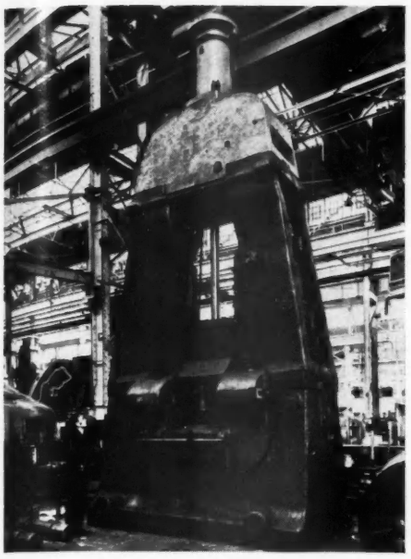
Fitted to the stand by three points is the lifting beam which spans the engine lengthwise and affords a degree of protection along the top of the engine. This beam, which is hinged at the front, can be opened vertically to facilitate engine fitting or removal and can be removed entirely if necessary.

Attached to the underside of the base of the stand are four shock absorbers, of the bonded rubber-to-metal type, which give a maximum vertical deflection of 2½ in. and are arranged to pick-up the base bolts of the existing Rolls-Royce transportation box.

For lifting and loading purposes, a system of formed channels, suitably braced, running from front to rear and across the base of the stand have been provided to permit handling by fork lift truck. Thus, lifting can be effected from both sides and the rear of the stand—the latter method being particularly suitable for loading into aircraft.



The Morfax transport stand for the Rolls-Royce Dart turbo-propeller engine. Is suitable for transport by rail or air, and is designed for handling by fork-lift truck.



Ceco-drop hammer of 8,000 lb. capacity claimed to be the largest in the world. Designed to give more blows per minute than conventional hammers and closer forging tolerances, it incorporates a steam or air-lift piston-rod unit which replaces the boards of the board hammer.

HIGH-SPEED DROP HAMMER

Machine of 8,000 lb. Capacity

Some five years ago, the Chambersburg Engineering Company of America introduced an improved type of gravity drop hammer, designed to fulfil the demands for more blows per minute, closer forging tolerances, reduced maintenance costs and greater safety in operation. Known as the " Ceco-drop," it is intended to supplement the board drop hammer, which is believed to have reached a stage of efficiency which leaves little scope for development. The improved hammer can be built in a range of sizes from 500 to 10,000 lb. capacity, but the largest so far made, which is shown in the illustration above, has a capacity of 8,000 lb. This model has been installed in the Sheffield plant of the English Steel Corporation, Limited.

The Ceco-drop incorporates a steam or air-lift piston-rod unit which replaces the boards of the board hammer, and results in increased lifting speed and therefore more blows per minute. The piston rod is considered to be expendable, and it was originally estimated that a working life of 200 operating hours would be more economical than the boards of the board drop hammer. A careful check of the first 20 installed, however, indicated that an average life of 800 hours had been achieved. Many rods have been in service for as long as 1,200 hours.

It is claimed that this efficiency has been maintained by some 400 Ceco-drops now in service and it is estimated that rod costs per production hour are one-fifth of those for boards used in board drop hammers of equal capacity. It has also been stated that in general the forgings made on the Ceco-drop required fewer blows than are necessary on a board drop hammer of equivalent size.

The whole structure of the 8,000 lb. model weighs 121 tons; it has a stroke of 54 in. and will strike a maximum blow of 45,000 ft.-lb. energy. The hammer rises over 20 ft. above the floor level, while 4 ft. of the 137 in. by 90 in. anvil is below the floor. The main parts of the hammer, the anvil, frames and yoke, are steel castings and were cast and machined by the English Steel Corporation. The hardening of the integral V-guides on the yoke was also carried out in their shops.

Erection of the hammer was done in the Darnall Works of the Davy and United Engineering Company, Limited, Sheffield, who build Chambersburg equipment, under licence, in this country. Alfred Herbert, Limited, P.O. Box No. 30, Edgwick Works, Coventry, Warwickshire, are sole agents for the Chambersburg Engineering Company and are authorised to offer service and advice concerning the Ceco-drop machines.

* * *

OIL BURNER FOR DOMESTIC HEATING

Automatic Operation without Moving Parts

The Kieft oil burner, introduced by Cyril Kieft and Company, Limited, Oil Burner Division, 13 Dudley-road, Wolverhampton, is designed for use with hot-water boilers supplying radiators and domestic hot water in houses and small commercial premises. It burns any light furnace oil, and is fully automatic in operation, being ignited and extinguished under the control of a thermostat. There are no moving parts. The burner is available in seven sizes, with rated outputs ranging from 35,000 B.Th.U. per hour with a consumption of 1·67 pints of oil, to 350,000 B.Th.U. per hour, consuming 17·85 pints of oil.

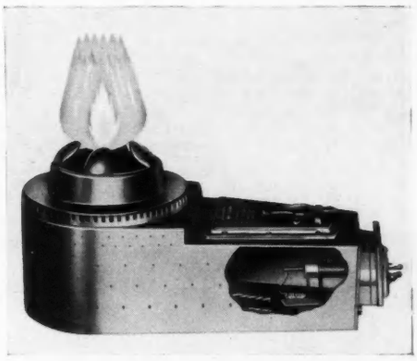
The burner, an example of which is shown in the illustration on the right (above), is fed with fuel oil from a storage tank through an electrically-operated valve under the control of a thermostat. When a fall in temperature causes the thermostat to operate it closes an electric circuit, which opens the fuel valve and simultaneously heats the 3 volt igniter coil in the burner. Electric current for control and ignition purposes is obtained from a small transformer.

The igniter consists of an alloy wire coil with an asbestos pad immediately beneath it. Oil flows along the floor of the burner, is raised by capillary action in the asbestos pad, and ignited by the heated coil. The small flame spreads rapidly, and covers the burner floor. As soon as sufficient heat has been generated the flame leaves the body of the burner and combustion takes place only in the combustion chamber. There is now no flame at the ignition end of the burner, and oil entering at this point is progressively vapourised until it is converted into a soot-free gas which burns when it reaches the secondary air ring at the throat of the burner.

In operation the oil continues to enter at the cool end of the burner, where the temperature is about 356 deg. F., and travels along the burner floor, the temperature rising as it moves along. The more volatile fractions of the oil are thus vapourised first, the heavier fractions being progressively vapourised as the oil moves along the burner until, at a point immediately below the secondary air ring the temperature is 695 deg. F. and vapourisation is complete.

When the set temperature is reached by the thermostat it reverses its operation, the igniter is cut off, the fuel valve closes, and the flame goes out.

The burner can be fitted to a Kieft boiler of 65,000 B.Th.U. per hour capacity. This boiler has a steel waterway and a cast iron outer casing, which is finished in vitreous enamel. The heating surface is 9 sq. ft. This boiler is specially designed to be used with the Kieft oil burner, but the burner can be fitted to a large number of boilers of other makes with, in most cases, little or no difficulty.



The Kieft domestic oil burner is designed for hot-water boilers up to 350,000 B.Th.U. per hour capacity. It is fully automatic in operation.

* * *

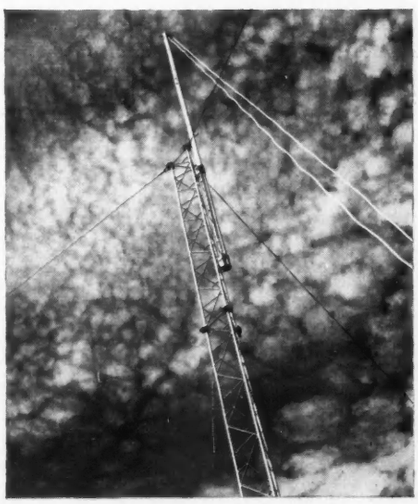
STAYED MAST BUILT FROM 10 FT. UNITS

Lightweight Structure from Welded Steel Tubes

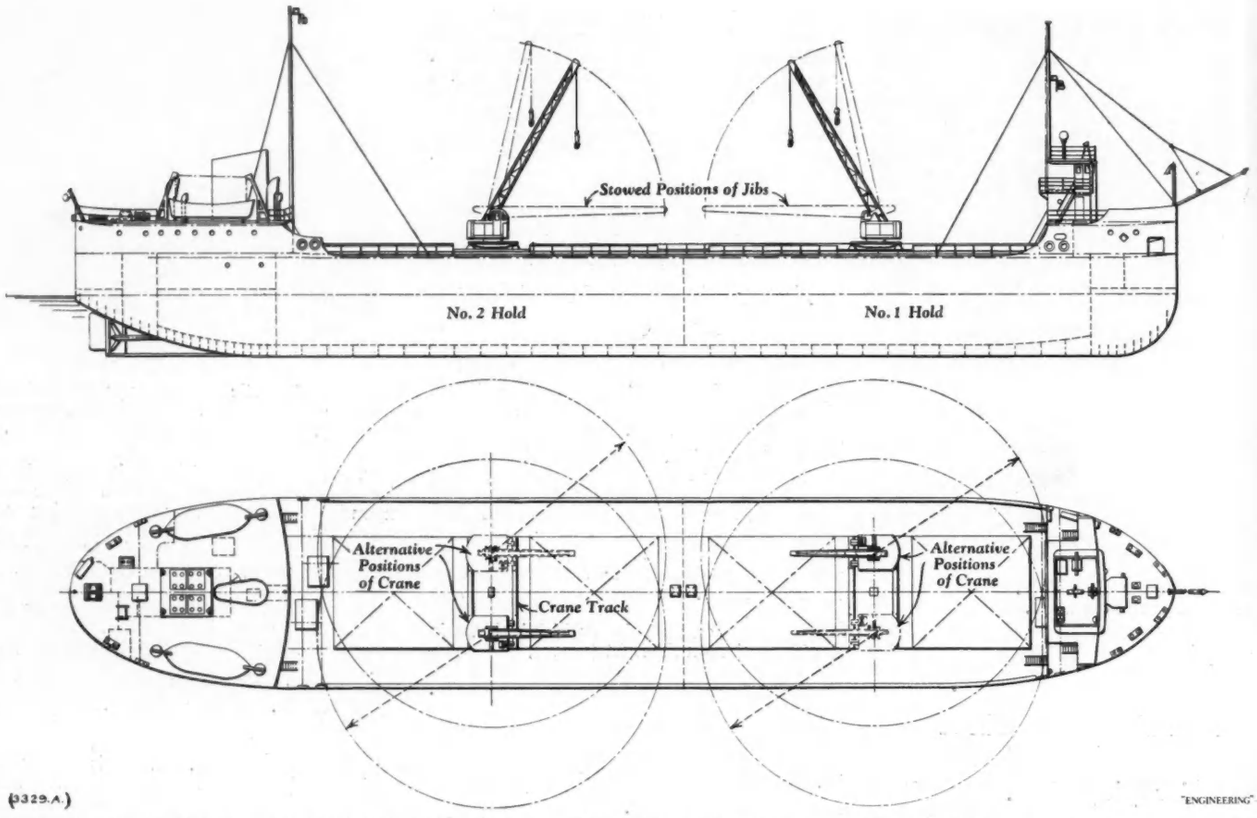
A stayed mast which is claimed to be cheap, light, transportable, climbable and easily erected has been designed by British Insulated Callender's Construction Company, Limited, 30 Leicester-square, London, S.W.1. The design is to be known as the Unit Radio Mast, and masts are being mass-produced by Painter Brothers, Limited, Hereford. Consisting of 10 ft. long units, the mast can be built up in multiples of 10 ft. to a maximum height of 150 ft. The mast is stayed at 20 ft. or 30 ft. intervals and stay plates are provided at each corner of the upper end of each unit. This light welded structure is of triangular section, each face of the triangle being 12 in. wide. Constructed chiefly of steel tubes, the mast weighs only 7 lb. per foot of length but a 150 ft. mast will withstand a head load of 1,000 lb. plus a wind of 100 m.p.h. Climbing rungs are incorporated in one face.

The units are constructed of mild steel and each consists of three tubular corner posts braced together by rods, and the assembly welded together in a rotating jig. After fabrication, the mast units are hot-dip galvanised and as the tubes are coated both inside and outside, the most efficient protection is given against corrosion. As erection progresses, additional units are added using two ½ in. bolts at each corner joint. All bolts and other accessories are galvanised.

Erection can be accomplished with little labour, the mast being built up, section by section, in the vertical, using a light-alloy derrick pole, as is shown in the accompanying illustration. These poles, together with the necessary fittings, are supplied as an extra item.



An aluminium-alloy derrick is used to lift sections of the mast during erection. Made from 10 ft. lengths, the mast can be stayed at 20 ft. or 30 ft. intervals.



Intended for the Great Lakes, the M.V. "Lachinedoc" has a deadweight of 3,200 short tons. Her two 480 b.h.p. engines give her a service speed of 8·7 knots.

MOTOR VESSEL "LACHINEDOC"

HYDROCONIC CONSTRUCTION DIESEL-ELECTRIC CARGO CRANES

A vessel incorporating some unusual features is the twin-screw M.V. Lachinedoc, which has been built at Newport, Monmouthshire, in the yard of the Atlantic Shipbuilding Company, Limited. Intended to serve as a cargo vessel on the Great Lakes and St. Lawrence waterways, she has been built to the order of N. M. Paterson and Sons, Limited, Ontario, and to the designs of Burness, Kendall and Partners, Limited, Dashwood House, Old Broad-street, London, E.C.2. An outline sketch is shown above.

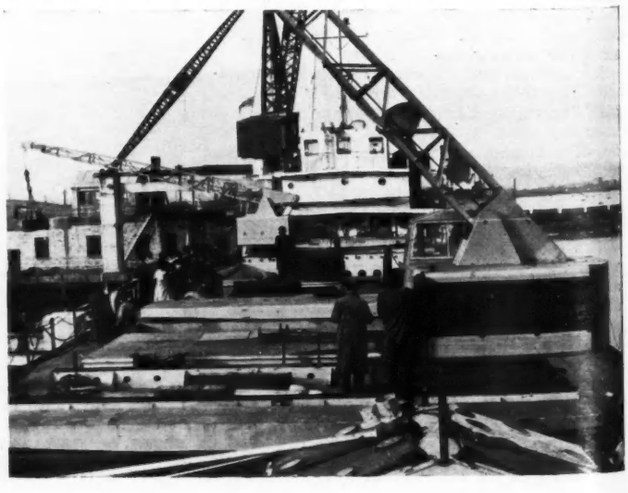
With an overall length of 259 ft. and moulded breadth of 43 ft. 10 in., she is the largest vessel yet built employing the "Hydroconic" method of design. For this, all the longitudinal members of the bow are straight and lie on the surface of a cone—not necessarily a right or a regular cone—the apex of which lies some distance forward of the vessel. This has the great merit that plating is curved in one plane only, and the shape of the cone can be selected to guide the water diagonally along the cone generators to the lower portions of the hull, whence it can rise smoothly along the buttocks, minimising any crossing of the bilge.

Structurally, the vessel is framed transversely on the sides, and longitudinally on the decks and the bottom and tank top in the parallel body. Transverse framing is used throughout the engine room, and the bottom and tank top forward of the parallel body are framed diagonally on the patent "Dioframe" system developed for some Hydroconic vessels.

In this method of framing, the longitudinals on the tank top and the bottom are cranked as they run out of the parallel body, and the bottom longitudinals thereafter follow the generating lines of the developed fore body. The tank top longitudinals have been arranged diagonally to follow the bottom longitudinals in plan view. The advantage of the reduction in overhead welding obtained by longitudinal framing in the parallel body is not offset by fairing difficulties in the fore body, as the Dioframes are, in fact, absolutely straight, running as they do along generating lines. Round bars are used as landings for the bilge strakes and for the lower stem. Figures quoted show that four-fifths of the overhead welding on the double bottom is eliminated by this method of construction, and welding time in man hours reduced by about 30 per cent. In addition, much work in bending the plating was avoided.

Extensive steering tests were carried out at the National Physical Laboratory, Teddington, with particular reference to obtaining acceptable steering astern. Large spade rudders sited inboard of the shaft centres, and a short skeg ending well forward of the propeller discs, have been adopted, and this arrangement has proved to be very satisfactory.

Resistance tests carried out on the vessel showed very good figures, comparing most favourably with normal practice; and by careful design of the stern gear, a propulsive coefficient has been achieved that is appreciably better than that of many twin screw canal ships. In fact it was stated that the power required was about 20 per cent. less than with vessels of other type and comparable size and speed. The main dimensions of the Lachinedoc are: overall length,



The two Diesel-electric cargo cranes can be moved to either side as required. The forward crane (in the background) shows the long out-board reach that can be obtained.

259 ft.; breadth, 43 ft. 10 in.; moulded depth, 22 ft. 6 in.; canal draft, 14 ft.; maximum draft, 16 ft. 6 in.; deadweight, 3,200 short tons in fresh water. The service speed will be 8·7 knots.

The main propulsion engines are two Lister-Blackstone EVSMGR.8 engines rated at 480 b.h.p. at 600 r.p.m. These drive through Modern Wheel Drive gearboxes of 3 : 1 ratio to manganese-bronze propellers 7 ft. in diameter. The main auxiliaries are two Lister-Blackstone ERMA.3 engines driving 100 kW generators of 220 volts direct current. Many of the parts of the main and auxiliary engines are interchangeable, which reduces the number of spares that have to be carried.

MOVABLE CRANES

Another unusual feature of the Lachinedoc (the name is that of a town in the Great Lakes with the final ending for Dominion of Canada) is that two Coles Diesel electric cranes, constructed by Steels Engineering Products Limited, Sunderland, have been fitted to handle cargo at those ports where dock facilities are not available. These cranes take the place of conventional derricks and have the advantage of being self-contained and independent of the ship's main machinery. They are mounted on carriages which slide on transverse tracks on the raised deck portions between the hatches. This enables them to be winched across to that side of the ship which is alongside the quay. When in position, the carriages are bolted down, as they also are when the vessel is at sea. In the illustration, which was taken looking forward, the two cranes are on opposite sides and the outboard reach obtainable can clearly be seen.

The cranes are standard models, F1210C, with 40 ft. steel lattice cantilever jibs, capable of lifting 3,000 lb. at 40 ft. or 6,000 lb. at 27 ft. radius. They can slew through a full circle. Both the holds are 92 ft. long and each is served by two hatchways 26 ft. wide, one having a length of 28 ft. and the other of 30 ft. The normal rigging will be with a single fall of rope giving a lifting speed of 150 ft. per minute; a double fall and block can be fitted if desired with a consequent reduction in hoisting speed.

Power is supplied by a Perkins P4 Diesel engine, driving a variable-voltage generator. Each motion of the crane is operated by a separate motor controlled by a lever in the driver's cab. The engine is speeded up by an accelerator pedal to supply the power needed for any operation. A heater, supplied from the engine cooling system, warms the driver's cab. Special waterproofing has been carried out on all parts of the mechanism to withstand the conditions met with at sea. Both intake and exhaust openings have removable doors and the front of the housing is covered with ¼ in. plate to give protection against blows. When at sea, a pin is dropped into the turntable to prevent the crane from slewing. and the jib is stowed fore and aft.

LAUNCHES AND TRIAL TRIPS

M.S. "DONA MYRTO."—Single-screw oil tanker, built and engined by William Doxford and Sons, Ltd., Sunderland, for the Compania Panamena Europea Navegacion Limitada, Panama (Agents: Chandris (England) Ltd., London, E.C.3.) Second of two oil tankers for these owners. Main dimensions: 505 ft. by 69 ft. 9 in. by 39 ft.; deadweight capacity, 16,730 tons on a draught of 30 ft. 1 in.; gross tonnage about 11,200. Doxford five-cylinder opposed-piston oil engine. Delivered, November 30.

S.S. "CHARLES H. MERZ."—Single-screw self-trimming collier, built by Hall, Russell & Co., Ltd., Aberdeen, for the Central Electricity Authority, London, S.W.1. (Managers: Stephenson Clarke, Ltd., London, E.C.3.) Main dimensions: 323 ft. between perpendiculars by 43 ft. 3 in. by 25 ft. 9 in.; deadweight capacity, about 3,700 tons on a draught of 18 ft. Direct-acting triple-expansion steam engine of reheat design, developing 1,475 i.h.p. in service, constructed by the North Eastern Marine Engineering Co. Ltd., Sunderland. Steam supplied by two oil-fired cylindrical boilers. Trial trip, November 30.

S.S. "DUKE OF LANCASTER."—Twin-screw vessel, with accommodation for 600 first-class and 1,200 third-class passengers and cargo, built and engined by Harland and Wolff Ltd., Belfast, for the Heysham to Belfast service of the British Transport Commission (London Midland Region), London. First vessel of an order for two. Main dimensions: 375 ft. overall by 55 ft. by 19 ft. 6 in. to main deck; gross tonnage, 5,075. Two sets of double-reduction geared steam turbines, developing 10,500 s.h.p. at a propeller speed not exceeding 225 r.p.m. Two Babcock and Wilcox oil-burning boilers manufactured by the shipbuilders. Launch, December 1.

S.S. "NORTH MONARCH."—Single-screw oil tanker, built by the Blythswood Shipbuilding Co., Ltd., Scotstoun, Glasgow, for the Compania Naviera Petrolera S.A., Panama. Main dimensions: 610 ft. between perpendiculars by 82 ft. by 44 ft. 6 in.; deadweight capacity, about 27,500 tons. Double-reduction geared steam turbines, developing about 10,000 s.h.p. at 105 r.p.m., constructed by David Rowan & Co., Ltd., Glasgow. Steam supplied by two Foster Wheeler oil-fired water-tube boilers. Launch, December 1.

THAMES TRANSPORTER.—Twin-screw shallow-draught vessel for landing fully-laden lorries, built by Thames Launch Works, Ltd., Eel Pie Island, Twickenham, for George Wilson & Co. (London), Ltd., on behalf of the Petroleum Development Co. (Oman) Ltd. Main dimensions: 60 ft. by 16 ft. 6 in. by 6 ft.; carrying capacity, 30 tons on a 3 ft. 6 in. draught. Two Diesel engines, each developing 80 b.h.p. at 900 r.p.m., constructed by Gleniffer Engines, Ltd., Glasgow, W.3. Completed, December 1.

S.S. "SPYROS NIARCHOS."—Single-screw oil tanker, built and engined by Vickers-Armstrongs (Shipbuilders) Ltd., Barrow-in-Furness, for Mr. Stavros S. Niarchos (Agents: Niarchos (London), Ltd.), London, W.1. Stated to be the largest oil tanker so far launched in the world. Main dimensions: 725 ft. between perpendiculars by 97 ft. 2 in. by 52 ft.; deadweight capacity, 47,750 tons; maximum draught, 37 ft. 9 in.; thirty-three cargo tanks with a maximum capacity of 14,000,000 Imperial gals. Pametrada-designed double-reduction geared steam turbines, developing 18,000 s.h.p. at 101·4 r.p.m. in service. Steam supplied by three Foster Wheeler "D"-type water-tube boilers. Sea speed, 17 knots on a 36 ft. draught. Launch, December 2. See also ENGINEERING, December 9, page 802.

M.S. "ABISKO."—Single-screw bulk-cargo carrying vessel, built and engined by the Götaverken Shipyard, Gothenburg, Sweden, for Trafikaktiebolaget Grängesberg-Oxelösund, Stockholm, Sweden. First of five sister ships. Main dimensions: 490 ft. overall by 64 ft. by 42 ft. 6 in.; deadweight capacity, 13,000 tons on a summer draught of 27 ft. 7 in. Götaverken seven-cylinder single-acting two-stroke heavy-oil engine, developing 6,200 i.h.p. at 112 r.p.m. Speed, 14½ knots fully loaded. Trial trip, December 7.

S.S. "HELDIA."—Single-screw oil tanker, built by Swan, Hunter, and Wigham Richardson, Ltd., Wallsend-on-Tyne, for Shell Tankers, Ltd. (Marine Managers for the Anglo-Saxon Petroleum Co., Ltd.), London, E.C.3. Main dimensions: 530 ft. between perpendiculars by 69 ft. 3 in. by 39 ft.; deadweight capacity, 18,150 tons on a draught of 29 ft. 9⅛ in.; gross tonnage, 12,000; oil-tank capacity, 17,470 tons. Double-reduction geared steam turbines, developing 7,500 s.h.p. at 100 r.p.m. in service, constructed by the Wallsend Slipway and Engineering Co., Ltd., Wallsend-on-Tyne. Steam supplied by two Babcock and Wilcox oil-burning boilers constructed by the Wallsend Co. Service speed, 14½ knots. Trial trip, December 12.

M.S. "ESCALANTE."—Single-screw cargo vessel, with accommodation for twelve passengers, built and engined by Harland and Wolff, Ltd., Govan, Glasgow, for the Royal Mail Lines, Ltd., London, E.C.3. A series of six other cargo vessels is on order for these owners. Main dimensions: 415 ft. between perpendiculars by 58 ft. 6 in. by 38 ft. 4 in. to shelter deck; gross tonnage, 7,790. Harland-B. and W. six cylinder single-acting two-stroke Diesel engine, arranged to operate on heavy fuel or Diesel oil. Delivered, December 13.

M.S. "BAMENDA PALM."—Single-screw cargo vessel, built and engined by Swan, Hunter, and Wigham Richardson, Ltd., Newcastle-upon-Tyne, for the Palm Line, Ltd., London, E.C.4. Main dimensions: 415 ft. between perpendiculars by 58 ft. by 35 ft. to shelter deck. Swan Hunter-Doxford four-cylinder oil engine, developing 4,500 b.h.p. at 118 r.p.m. in service. Engine arranged to burn boiler fuel. Launch, December 14.

H.M.S. "HARDY."—First completed vessel of the Blackwood class of anti-submarine frigates. Built and engined by Yarrow & Co., Ltd., Scotstoun, Glasgow, for the Admiralty, London, S.W.1. Length, 310 ft. overall; and extreme breadth, 33 ft. Designed to work in conjunction with anti-submarine frigates of the Whitby class. Armament comprises three 40 mm. Bofors guns and two three-barrelled anti-submarine mortars. Propelled by geared steam turbines designed by the English Electric Co., Ltd. Provisionally accepted for naval service on December 15.

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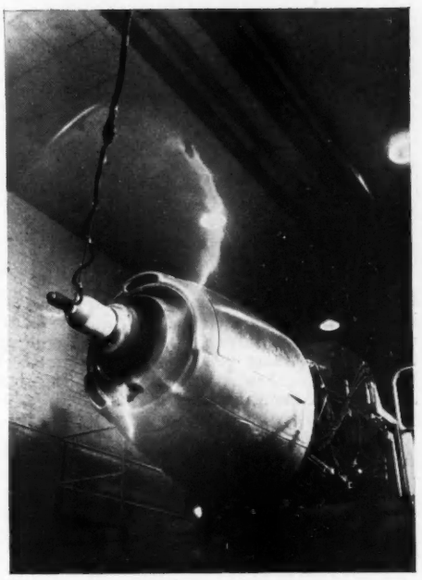


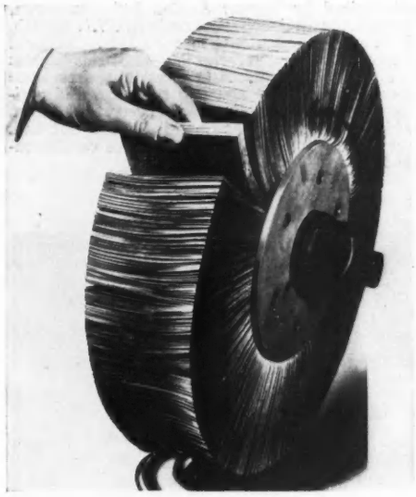
The 4,000 h.p. Bristol BE25 turbo-propeller is now running on its test bed. It is claimed to be the first aero-engine to make its initial test in such a state of near completion.

BRISTOL BE25 TURBO-PROPELLER ON TEST

The BE25 supercharged turbo-propeller engine, constructed by the Bristol Aeroplane Company, Limited, Filton, Bristol, is now running on the test bed. To cut development time to the minimum, the engine has been built as a complete power plant before being placed under test and is the first Bristol engine (and probably the first engine in the world) ever to make its initial test run in this form. Particular attention has been paid in the design of the BE25 to the grouping of accessories to ensure maximum accessibility for servicing and maintenance.

Sixty BE25 engines have been ordered by British Overseas Airways Corporation for later installation in Britannia 300LR aircraft. The BE25 engine is also the power unit of the planned Bristol/Convair/Canadair project for a long-range 120-seat airliner in the 500 m.p.h. class which will be able to operate an all-weather scheduled non-stop trans-Atlantic service in both directions. It is envisaged that this aircraft and its engines will be built concurrently on both sides of the Atlantic.

Design studies for the Bristol BE25 turbo-propeller began towards the end of 1952, and in 1954 the engine was awarded a Ministry of Supply development contract. Unlike most gas turbines, which progressively lose power as they climb, the BE25 will provide a constant power of 4,000 h.p. from sea level up to about 20,000 ft. It will therefore give full take-off power at any airfield in the world, irrespective of climate or elevation. This will eliminate the need for the operator to reduce an aircraft's take-off weight in the tropics (normally necessary because of decreased take-off power) and will ensure that, in the event of an engine failure at take-off, the full three-engine power available at temperate sea level conditions can still be called upon.



Over a thousand segments of abrasive-coated cloth radiating from a central hub form the basis of the 3M P.G. polishing wheel. Long operating life and a profiling action which simplifies the polishing of contoured surfaces are among the advantages of the wheel which retains its efficiency by the continuous exposure of fresh grain.

POLISHING WHEEL WITH PROFILING ACTION

Sections of Abrasive Cloth Attached to Central Hub

Segments of coated abrasive cloth radiating from a central hub form the basis of a polishing wheel recently introduced by the Minnesota Mining and Manufacturing Company, Limited, 167 Strand, London, W.C.2. Known as the 3M P.G. wheel, this unit has already been widely used in the United States, and it is understood that in one plant a P.G. wheel lasted 35 hours where hitherto dressed wheels performing the same operation had endured for a maximum of 18 to 20 minutes.

In the P.G. wheel there are more than 1,000 segments of a special abrasive-coated cloth, which remains efficient during any operation owing to the continuous exposure of fresh grain as wear takes place. In addition, its self-conforming profiling action eliminates many of the difficulties of polishing contoured surfaces. The wheel requires no "breaking in" or dressing, and it is capable of performing in one operation all the jobs formerly requiring the use of dressed wheels and buffs.

The 3M company are arranging demonstrations of the wheel in London, Birmingham and Manchester, and are also prepared to show the wheel in operation on manufacturers' premises to indicate its efficiency with different products.

* * *

SWARF BIN AND CARRIER

Increasing Workshop Safety

A swarf bin and carrier has been developed by Wickley Limited, St. James', Chichester, Sussex, for simplifying the collection and salvage of swarf and promoting workshop tidiness. It is intended that the bin shall stand beside each machine providing a handy receptacle for swarf, bar ends, and any other materials.

On his rounds, a labourer brings up an empty bin on the carrier, drops the bin beside the machine, picks up the loaded bin with the carrier, takes it to the stores, clips a sack on it and empties the bin. He is then ready to go to the next machine and repeat the process.

The bin, 15 in. square by 21 in. high, is of 18 s.w.g. mild steel sheet and incorporates a cam-action sack grip, and is fitted with trunnions for use with the trolley. The latter, of welded mild steel, has 7 in. diameter rubber-tyred cast-iron wheels. Both the bin and the carrier are shown in the accompanying illustration.

* * *

INDUSTRIAL POWER PACKS

Range of Standard Engines

An agreement has recently been reached between the Standard Motor Company, Limited, and Auto Diesels Limited, Uxbridge, Middlesex, whereby the latter will adapt standard engines for industrial purposes and also undertake their distribution. The new range will be known as the Stad engine and will include petrol, paraffin, T.V.O., and Diesel types covering the range from 8 to 50 h.p. The engines will be available as separate units or combined with alternators, pumps, etc. A typical example is the 6·5 kVA set in the illustration; it is driven by a 948 c.c. petrol engine.

* * *

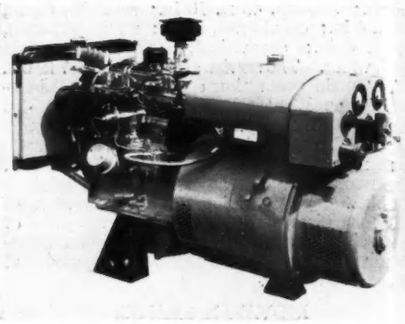
HEATING DIESEL TRAINS

"Flash" Steam Boilers

Originally developed in America for heating Diesel-engined trains, the Vapor steam generator is now being made in this country by J. Stone and Company (Deptford), Limited, Deptford. It is an oil-fired forced-circulation boiler without drums, headers or internal reservoirs, and has been widely used on railways and ships.

The water is circulated in three banks of tubes around a central combustion space, the tubes being connected to form a continuous coil. Fuel is admitted to the burner and burns with great turbulance giving very high rates of heat release and good scrubbing of the tubes. The hot gases are fed back and help to pre-heat the incoming air. Automatic protection is given for flame or water failure. The heat release is controlled to give about 90 per cent. evaporation of the circulating water, the remaining 10 per cent. being used to scour the tubes and is removed by a steam trap to the sump. The thermal efficiency varies from 78 to 82 per cent. over the operating range of the boiler. Two minutes only are required to raise steam. The boilers are available in seven sizes with horse-power ratings from 18 to 160. The small space required is one of their major advantages.

The regular collection of swarf and rubbish does much to increase safety as well as tidiness in the workshop.



An example of the applications of the Stad range of engines is the 6·5 kVA alternator set shown here.

CATHODIC PROTECTION OF PIPE-LINES

Metal-Plate Rectifiers

Among the metal-plate rectifiers which the Hackbridge and Hewittic Electric Company, Limited, Walton-on-Thames, Surrey, are supplying for the cathodic protection of buried metal structures mention may be made of a unit, which has been designed to give a direct-current of 80 amperes at 6 to 60 volts in an ambient temperature up to 55 deg. C. It is intended for the cathodic protection of an oil pipe-line in the Middle East. The rectifier starter and regulating transformer are oil-immersed in a weatherproof tank; the operating wheel, as well as the measuring instruments and terminals, are enclosed in a locked box to prevent interference.

Generally speaking these equipments are built to a basic constructional design, but the rating and electrical arrangements can be modified to suit particular requirements. The voltage can be controlled either by transformer tapping switches or by a regulating transformer; the latter method is adopted for the new rectifiers.

* * *

THRUST REVERSER AND SOUND SUPPRESSOR

The Boeing Airplane Company, Seattle, Washington, U.S.A., are developing a combined thrust-reverser and sound-suppressor unit for installation on the tailpipe of the Boeing 707 airliner jet engines. Static and taxying tests have already been carried out using an experimental fixed thrust reverser on the prototype Boeing 707.

The sound suppressor is designed to regulate the mixing of exhaust gases and surrounding air so that less noise is produced, particularly in those frequency ranges where sound reduction is most desired. It is claimed that there is no appreciable loss in the total available thrust.

* * *

NEW JET TRAINER

A new jet trainer—the Student—is now under construction at the works of F. G. Miles Limited, Shoreham, and is expected to be ready for flight trials early next year. In quantity production this aircraft is expected to cost between £6,500 and £7,250.

The M.100 Student was designed as a private venture by the Miles brothers in 1953 to Ministry of Supply requirements for a foolproof basic jet training aircraft—safe and economical to fly and cheap to produce. It will be powered by Blackburn-Turboméca Marboré jet engines.

In reporting the launching of the "Spyros Niarchos" (page 802, December 9), we stated that the five-bladed "Novoston" propeller was made by J. Stone and Company (Deptford), Limited; the company should have been described as J. Stone and Company (Charlton), Limited.

FORTHCOMING EXHIBITIONS AND CONFERENCES

This list, arranged chronologically, appears in the last issue of each month. Events appearing for the first time, and alterations of dates, places, etc., are indicated by an asterisk (*). Particulars of exhibitions and conferences not included below may have appeared in ENGINEERING, *October* 28, *page* 614; *or November* 25, *page* 742. *Organisers are invited to send to the Editor particulars of coming events as soon as arrangements are made.*

***Problems of Aircraft Production Conference.**—Fri. and Sat., Jan. 6 and 7, at The University, Southampton. Organised by the Southern Section of the Institution of Production Engineers. Apply to the secretary of the Institution, 10 Chesterfield-street, London, W.1. Tel. GROsvenor 5254.

National Plant Maintenance and Engineering Show, Seventh.—Mon., Jan. 23; to Thurs., Jan. 26, at the Convention Hall, Philadelphia. Organised by Clapp and Poliak Inc., 341 Madison-avenue, New York 17, U.S.A.

American Institute of Electrical Engineers, Winter General Meeting.—Mon., Jan. 30, to Fri., Feb. 3, at New York. Offices of the Institute: 33 West 39th-street, New York 18, U.S.A.

***Special Steels and Alloys, Symposium on Production, Properties and Applications of.**—Wed., Feb. 1, to Fri., Feb. 3, at Jamshedpur, India. Apply to Dr. B. R. Nijhawan, National Metallurgical Laboratory, Council of Scientific and Industrial Research, Jamshedpur, India.

***Electronics and Productivity Exhibition and Conference.**—Mon., Feb. 6, to Thurs., Feb. 9, at the Kelvin Hall, Glasgow. Organised by the South of Scotland Electricity Board, 351 Sauchiehall-street, Glasgow, C.2.

Canadian Hardware and Housewares Exhibition.—Mon., Feb. 6, to Thurs., Feb. 9, in the Automotive Building, Canadian National Exhibition Grounds and the Royal York Hotel, Toronto. Information obtainable from Mr. A. P. Wales, Dudley House, Southampton-street, London, W.C.2. Tel. TEMple Bar 8947.

Stationery and Book Trades Fair, National.—Mon., Feb. 6, to Fri., Feb. 10, at the Royal Horticultural Society's Old and New Halls, Vincent-square and Greycoat-street, London, S.W.1. Organised by the National Newsagent (Exhibitions) Ltd., 149 Fleet-street, London, E.C.4. Tel. CITy 2604.

Stationery Trade Fair.—Mon., Feb. 6, to Fri., Feb. 10, at Blackpool. Organised by the Stationers' Association of Great Britain and Ireland, 6 Wimpole-street, London, W.1. Tel. LANgham 9256.

***Power Farming Conference, Sixth National.**—Tues., Feb. 7, to Thurs., Feb. 9, at the Winter Gardens, Bournemouth, Hants. Apply to the organiser, National Power Farming Conference, Dorset House, Stamford-street, London, S.E.1. Tel. WATerloo 3333.

Winter Concreting Symposium.—Sun., Feb. 12, to Fri., Feb. 17, at Copenhagen. Apply to the organising secretary, Rilem Symposium 1956, c/o The Danish National Institute of Building Research, 20 Borgergade, Copenhagen K, Denmark.

Agricultural Machinery and Equipment Exhibition, 36th International.—Sun., Feb. 12, to Sun., Feb. 19, in Brussels. Organised by the Société de Mécanique et d'Industries Agricoles S.A., 29 Rue de Spa, Brussels.

Scottish Dairy Show.—Tues., Feb. 14, to Fri., Feb. 17, at Kelvin Hall, Glasgow. Organised jointly by the Corporation of Glasgow, and the Glasgow Agricultural Society, Kelvin Hall, Glasgow.

American Institute of Mining and Metallurgical Engineers, Annual Meeting.—Sun., Feb. 19, to Thurs., Feb. 23, at New York. Offices of the Institute: 29 West 39th-street, New York 18, U.S.A.

Hardware Trades Fair.—Mon., Feb. 20, to Fri., Feb. 24, at the Royal Horticultural Society's Old and New Halls, Vincent-square and Greycoat-street, London, S.W.1. Apply to the organising secretary, Hardware Trades Fair, 74 Holland Park, London, W.11. Tel. PARk 7723.

Business Efficiency Exhibition.—Mon., Feb. 20, to Sat., Feb. 25, at Bingley Hall, Birmingham. Organised by the Office Appliance and Business Equipment Trades Association, 11-13 Dowgate-hill, Cannon-street, London, E.C.4. Tel. CENtral 7771.

Radio and Domestic Appliance Exhibition.—Wed., Feb. 22, to Sat., Feb. 25, in the Memorial Hall, Nairobi. Organised by the Radio Traders' Association of East Africa, P.O. Box No. 6742, Nairobi, Kenya.

British Industries Fair.—Wed., Feb. 22, to Fri., Mar. 2 (including British Toy Fair), at Earl's Court, London, S.W.5. (Organised jointly with British Toy Manufacturers' Association.) Also Mon., April 23, to Fri., May 4, at Olympia, London, W.14, and at Castle Bromwich, Birmingham. Apply to British Industries Fair, Ltd., 9 Kingsway, London, W.C.2. Tel. COVent Garden 1461; or to general manager, B.I.F., 95 New-street, Birmingham, 2. Tel. Midland 5021.

Modern Gardening Equipment Exhibition.—Thurs., Feb. 23, to Thurs., Mar. 1, at the Central Hall, Westminster, London, S.W.1. Organised by Universal Exhibitions Ltd., 74 Holland Park, London, W.11. Tel. PARk 7360.

Automobiles, 15th International Exhibition.—Fri., Feb. 24, to Sun., Mar. 4, at Copenhagen. Organised by the Sammenslutningen af Automobilfabrikanter og Imporotrer, Amaliegade 22, Copenhagen K, Denmark.

Brighton Smallwares Trade Fair.—Mon., Feb. 27, to Fri., Mar. 2, at the Metropole Hotel, Brighton. Organised by Trade and Technical Exhibitions, Ltd., 1 Dorset Buildings, Salisbury-square, London, E.C.4. Tel. FLEet 1555.

American Society for Testing Materials.—*National Meeting:* Mon., Feb. 27, to Fri., Mar. 2, at the Hotel Statler, Buffalo, N.Y. *Annual Meeting:* Sun., June 17, to Fri., June 22, at Atlantic City, N.J. Held in association with the Exhibit of Testing and Scientific Apparatus. *Pacific Coast National Meeting:* Sun., Sept. 16, to Sat., Sept. 22, at the Hotel Statler, Los Angeles, Calif. Offices of the Society: 1916 Race-street, Philadelphia, Pa., U.S.A.

Frankfurt International Spring Fair.—Sun., Mar. 4, to Thurs., Mar. 8, at Frankfurt. *Agents:* Lep Transport Ltd., Sunlight Wharf, Upper Thames-street, London, E.C.4. Tel.: CENtral 5050.

Ideal Home Exhibition.—Tues., Mar. 6, to Sat., Mar. 31, at Olympia, London, W.14. Organised by Associated Newspapers Ltd., New Carmelite House, London, E.C.4. Tel. FLEet 6000.

***Television Society's Exhibition.**—Tues., Mar. 6, in London. Organised by the Television Society, 164 Shaftesbury-avenue, London, W.C.2. Tel. TEMple Bar 3330. Date postponed from January 5.

***Extraction Metallurgy of Some of the Less Common Metals, Symposium.**—Thurs., and Fri., Mar. 22 and 23, at the Royal Society of Arts, John Adam-street, London, W.C.2. Organised by the Institution of Mining and Metallurgy, 44 Portland-place, London, W.1. Tel. LANgham 3802.

Plant and Process Dynamic Characteristics, Conference on.—Wed., April 4, to Fri., April 6, at the Engineering Laboratory, The University, Cambridge. Organised by the Control Section of the Society of Instrument Technology, 184 Sherwood Park-road, Mitcham, Surrey. (Tel. POLlards 3620). Apply to the secretary, S.I.T. 1956 Conference, Engineering Laboratory, Trumpington-street, Cambridge.

***Digital Computer Techniques Convention.**—Mon., April 9, to Fri., April 13, at the Institution's headquarters. Organised by the Institution of Electrical Engineers, Savoy-place, Victoria-embankment London, W.C.2. Tel. TEMple Bar 7676.

***Royal Society for the Promotion of Health; Exhibition and Conference.**—Tues., April 24, to Fri., April 27, at Blackpool. Apply to the Society's offices: 90 Buckingham Palace-road, London, S.W.1. Tel. SLOane 5134.

Valencia Samples Fair, 34th International.—Tues., May 1, to Sun., May 20, at Valencia. Organised by the Feria Muestrario International de Valencia, Llano del Real 2, Valencia. Information obtainable from the Economic Department, Spanish Embassy, 12 Cadogan-place, London, S.W.1. Tel. SLOane 6181.

***Electrical Equipment for Aircraft, Symposium.**—Wed., May 2, to Fri., May 4, at the Institution's headquarters. Organised by the Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. Tel. TEMple Bar 7676.

***Applied Spectroscopy, International Colloquium on.**—Mon., May 14, to Sat., May 19, at Amsterdam. Apply to Dr. F. Freese, Laboratory of Analytical Chemistry, Nieuwe Achtengracht, Amsterdam c, Holland.

***Production Exhibition.**—Wed., May 23, to Thurs., May 31, at Olympia, London, W.14. Organised by Andry Montgomery Ltd., 32 Millbank, London, S.W.1. Tel. TATe Gallery 8134.

Mediterranean Fair, Eleventh.—Fri., May 25, to Sun., June 10, at Palermo. Organised by the Fiera del Mediterraneo, Piazza General Cascino, Palermo, Italy.

Packaging Salon, Fifth International; and 34th International Fair.—Tues., May 29, to Wed., June 13, at Padua. *Agents:* Italian Chamber of Commerce for Great Britain and British Commonwealth, 652 Grand Buildings, Trafalgar-square, London, W.C.2. Tel. WHItehall 5521.

Vapour-Phase Chromatography.—Wed., May 30, to Fri., June 1, in London. Organised by the Hydrocarbon Research Group of the Institute of Petroleum, 26 Portland-place, London, W.1. (Tel. LANgham 2250.) Apply to the organising secretaries: Mr. D. M. Desty and Mr. H. C. Rampton, The Research Station, British Petroleum Co., Ltd., Sunbury-on-Thames.

Bath and West Agricultural Show.—Wed., May 30, to Sat., June 2, at Cardiff. Organised by the Bath and West and Southern Counties Society, 3 Pierrepont-street, Bath. Tel. Bath 3010.

***High Tension Networks, 16th International Conference on.**—Wed., May 30, to Sat., June 9, at Centre Marcelin Berthelot, 28 Rue Saint Dominique, Paris. Organised by the Conférence Internationale des Grands Réseaux Electriques. Apply to above address.

Barcelona Samples Fair, 24th International.—Fri., June 1, to Wed., June 20, at Barcelona. Apply to the Spanish Tourist Service, 4 West Halkin-street, Belgrave-square, London, S.W.1. Tel. SLOane 6124; or to the Economic Department, Spanish Embassy, 12 Cadogan-place, London, S.W.1. Tel. SLOane 6181.

***Molecular Structure and Spectroscopy, Annual Symposium.**—Mon. June 11, to Fri., June 15, at Columbus, Ohio. U.S.A. Apply to the secretariat, Department of Physics, Ohio State University, Columbus, Ohio, U.S.A.

***Spectroscopy, Fourth Meeting of Joint Commission on.**—Mon., June 11, to Fri., June 15, at Columbus, Ohio, U.S.A. Organised by the International Council of Scientific Unions. Apply to the secretary, Joint Commission on Spectroscopy, Zeeman Laboratorium, Plantage Muidergracht 4, Amsterdam 4, Holland.

World Power Conference, Fifth Plenary.—Sat., June 16, to Sat., June 23, in Vienna. Organised in Austria by the Oesterreichischen Nationalkomitees der Weltkraftkonferenz Schwarzenbergplatz 1, Vienna 1. Apply to Mr. C. H. Gray, secretary, World Power Conference, 201–202 Grand Buildings, Trafalgar-square, London, W.C.2. Tel. WHItehall 3966. See ENGINEERING, February 11, 1955, page 168, and February 25, 1955, page 249.

Testing and Scientific Apparatus and Laboratory Supplies, 12th Exhibit of.—Sun., June 17, to Fri., June 22, at Atlantic City, N.J. Organised by the American Society for Testing Materials in connection with their Annual Meeting. Offices of the Society: 1916 Race-street, Philadelphia 3, Pa., U.S.A.

Civil Engineering Problems in the Colonies, Conference.—Mon., June 18 to Fri., June 22, at Institution of Civil Engineers, Great George-street, London, S.W.1. Apply to the Secretary of the Institution at that address. Tel. WHItehall 4577.

***Acoustics, Second Congress of International Commission on.**—Mon., June 18, to Sun., June 24, at Cambridge, Mass., U.S.A. Apply to Professor P. Fleury, International Union of Pure and Applied Physics, 3 Boulevard Pasteur, Paris 15e.

Machine Tool Exhibition, International.—Fri., June 22, to Fri., July 6, at Olympia, London, W.14. Organised by the Machine Tool Trades Association, Victoria House, Southampton-row, London, W.C.1. Tel. HOLborn 4667.

Trieste International Trade Fair, Eighth.—Sun., June 24, to Sun., July 8, at Trieste. *Agents:* Italian Chamber of Commerce for Great Britain and British Commonwealth, 652 Grand Buildings, Trafalgar-square, London, W.C.2. Tel. WHItehall 5521.

Colonial Highways Problems, Round Table Conference on.—Mon., June 25, to Wed., June 27, at the Institution of Civil Engineers, Great George-street, London, S.W.1. Organised in conjunction with the Colonial Office. Apply to the secretary of the Institution at the above address. Tel. WHItehall 4577.

***International Association of Bridge and Structural Engineering, Fifth International Congress.**—Mon., June 25, to Mon., July 2, at Lisbon, Portugal. Apply to Mr. L. Gretener, secretary of the Association, Swiss Federal Institute of Technology, Zürich, Switzerland. (Alteration of dates.)

***Glass Congress, Fourth International.**—Commencing Mon., July 2, at Paris. Apply to the secretary, Institut du Verre, 24 Rue Dourlet, Charleroi, Belgium.

International Union of Forest Research Organisations, 12th International Congress.—Fri., July 6, to Sat., July 14, at Oxford. Apply to Professor A. de Philippis, Instituto di Selvicoltura, Piazzale delle Cascine, Florence, Italy.

New York Lamp Show.—Sun., July 9, to Fri., July 13, at New Yorker Hotel, New York. Apply to Mr. George F. Little, 220 Fifth-avenue, New York, 1.

Duke of Edinburgh's Study Conference on Human Problems of Industrial Communities within the Commonwealth and Empire.—Mon., July 9, to Fri., July 27, at Oxford.

Great Yorkshire Agricultural Show.—Tues., July 10 to Thurs., July 12, at Harrogate. Organised by the Yorkshire Agricultural Society, Cliftonfield, Shipton-road York. Tel. York 3102.

Molecules in Cosmic Sources, Seventh International Astrophysical Symposium on.—Thurs. July 12 to Sat. July 14, at Liége, Belgium. Apply to Professor Harold C. Urey, Institute for Nuclear Studies, University of Chicago, Chicago 27, Ill., U.S.A.

International Society of Photogrammetry, Eighth Congress.—Tues., July 17, to Thurs., July 26, at Stockholm. Apply to Mr. P. O. Fagerholm, Bragevägen 8, Stockholm, Sweden.

Housing and Town Planning, International Congress.—Sun., July 22, to Sat., July 28, at Vienna. Apply to Mr. H. van der Weijde, secretary-general to the Federation of Housing and Town Planning, Paleisstraat 5, The Hague, Holland.

Royal Welsh Agricultural Show.—Wed., July 25 to Fri., July 27, at Rhyl. Apply to the secretary, the Royal Welsh Agricultural Society, Queen's-road, Aberystwyth. Tel. Aberystwyth 7551.

Australian World's Fair.—Thurs., July 26, to Sat., Aug. 4, at Sydney. Apply to the managing director, Australian World's Fair, 234 Clarence-street, Sydney, N.S.W., Australia.

British Association Meeting.—Wed., Aug. 29, to Wed., Sept. 5, in Sheffield. Apply to the secretary, British Association for the Advancement of Science, Burlington House, Piccadilly, London, W.1. Tel. REGent 2109.

Foundry Trades Fair, International (GIFA).—Sat., Sept. 1, to Sun., Sept. 9, at the Fair Halls, Düsseldorf. To be held in connection with the 23rd International Foundry Congress. Organised by the Nordwestdeutsche Ausstellungs-Gesellschaft m.b.H. (NOWEA), Ehrenhof 4, Düsseldorf, Germany. *Agents:* John E. Buck & Co., 47 Brewer-street, London, W.1. Tel. GERrard 7576. See ENGINEERING, October 21, 1955, page 565.

Strasbourg European Fair, 31st.—Sat., Sept. 1, to Sun., Sept. 16, at Strasbourg. *Agent:* R. C. Liebman, 178 Fleet-street, London, E.C.4. Tel. CITy 5889.

Frankfurt International Autumn Fair.—Sun., Sept. 2, to Thurs., Sept. 6, at Frankfurt. *Agents:* Lep Transport, Ltd., Sunlight Wharf, Upper Thames-street, London, E.C.4. Tel. CENtral 5050.

German Agricultural Show.—Sun., Sept. 9, to Sun., Sept. 16, at Hanover. Apply to the Deutsche Landwirtschafts-Gesellschaft, Niedenau 48, Frankfurt-on-Main.

***Electron Transport in Metals, Symposium on.**—Mon., Sept. 10, to Fri., Sept. 14, at Ottawa, Canada. Apply to Professor P. Fleury, International Union of Pure and Applied Physics, 3 Boulevard Pasteur, Paris 15e.

***Fatigue of Metals Conference.**—Mon., Sept. 10, to Fri., Sept. 14, in London. Organised by the Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. Tel. WHItehall 7476.

Building Plant Exhibition.—Wed., Sept. 12, to Wed., Sept. 19, at the D and E Car Parks, Gosforth Park Racecourse, Great North-road, Newcastle-upon-Tyne. Organised by the Ministry of Works, Lambeth Bridge House, London, S.E.1. Tel. RELiance 7611.

***Static Electricity in Textiles, Overseas Conference on.**—Thurs., Sept. 13, to Mon., Sept. 17, at Zürich. Apply to the general secretary, Textile Institute, 10 Blackfriars-street, Manchester 3.

Function and Education of Welding Engineers, Conference on.—In mid-September. Organised by the Institute of Welding. 2 Buckingham Palace-gardens, London, S.W.1. Tel. SLOane 9851.

***Physical Chemistry of Processes at High Pressures, Conference.**—Thurs. and Fri., Sept. 20 and 21, at Glasgow. Apply to the secretary, Faraday Society, 6 Gray's Inn-square, London, W.C.1. Tel. CHAncery 8101.

Commercial Motor Transport Exhibition, International.—Fri., Sept. 21, to Sat., Sept. 29, at Earl's Court, London, S.W.5. Organised by the Society of Motor Manufacturers and Traders, Ltd., 148 Piccadilly, London, W.1. Tel. GROsvenor 4040.

***Science of Photography, International Conference on.**—Mon., Sept. 24, to Thurs., Sept. 27, at Cologne. Apply to Dr. Walter Schürmeyer, Deutsche Gesellschaft für Photographie e.v., Hohenstaufenring 48/54, Cologne, Germany.

National Fuel Efficiency Exhibition.—Tues., Oct. 2, to Wed., Oct. 10, at Olympia, London, W.14. Organised by Provincial Exhibitions Ltd., City Hall, Deansgate, Manchester, 3. Tel. Deansgate 6363.

Motor Show (41st International Motor Exhibition).—Wed., Oct. 17, to Sat., Oct. 27, at Earl's Court, London, S.W.5. Organised by the Society of Motor Manufacturers and Traders, Ltd., 148 Piccadilly, London, W.1. Tel. GROsvenor 4040.

Cycle and Motor Cycle Show, 31st International.—Sat., Nov. 10, to Sat., Nov. 17, at Earl's Court, London, S.W.5. Organised by the British Cycle and Motor Cycle Manufacturers' and Traders' Union, Ltd., The Towers, Warwick-road, Coventry (Tel. Coventry 62511); and 20-23 Lincoln's Inn Fields, London, W.C.2. Tel. CHAncery 4152.

Public Works and Municipal Services Congress and Exhibition.—Mon., Nov. 12, to Sat., Nov. 17, at Olympia, London, W.14. Organised by the Municipal Agency, Ltd., 70 Victoria-street, London, S.W.1. Tel. VICtoria 9132.

***Smithfield Show and Agricultural Machinery Exhibition.**—Mon., Dec. 3, to Fri., Dec. 7, at Earl's Court, London, S.W.5. Apply to the exhibition manager, Smithfield Show Joint Committee, 148 Piccadilly, London, W.1. Tel. GROsvenor 4040.

***United States World Trade Fair.**—Sun., April 14, to Sat., April 27, 1957, at the New York Coliseum, New York. Managers: The Charles Snitow Organisation, Inc., 331 Madison-avenue, New York 17. Information may be obtained from the British Commonwealth Chamber of Commerce in the United States, 677 Fifth-avenue, New York 22.

***Internal-Combustion Engine Congress, Fourth International.**—Mid-June, 1957, at Zürich. Apply to Mr. C. C. M. Logan, secretary, British National Committee, 6 Grafton-street, London, W.1. Tel. HYDe Park 5107. See ENGINEERING, December 2, 1955, page 753.

***Atoms Exhibition.**—August, 1957, at Geneva. Address of organising committee: 1 Place du Lac, Geneva, Switzerland. See ENGINEERING, December 16, 1955, page 816.

NOTICES OF MEETINGS

Aslib

LONDON
"The Documentation of History by Film," by Sir Arthur Elton, Bt. Royal Society of Arts, John Adam-street, Adelphi, W.C.2. Thurs., Jan. 12, 6 p.m.*

British Institution of Radio Engineers

LONDON
"Domestic Tape-Recording Applications, with Special Reference to Stereophonic Reproduction," by M. B. Martin and D. L. A. Smith. London Section. London School of Hygiene and Tropical Medicine, Keppel-street, W.C.1. Thurs., Jan. 5, 6.30 p.m.*
LIVERPOOL
"Electronic Instrumentation for Nuclear Power," by R. J. Cox. Merseyside Section. Chamber of Commerce, 1 Old Hall-street, Liverpool, 3. Wed., Jan. 4, 7 p.m.
MANCHESTER
"Radio and Television Interference: Its Growth and Effects," by M. Smith. North Western Section. College of Technology, Sackville-street, Manchester. Thurs., Jan. 5, 6.30 p.m.
NEWCASTLE-UPON-TYNE
"Some Interference Problems Associated with the Television Service," by J. C. Belcher. North Eastern Section. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Wed., Jan. 11, 6 p.m.

British Interplanetary Society

LONDON
"Evolution of Our Galaxy," by Dr. H. P. Wilkins. Caxton Hall, Victoria-street, S.W.1. Sat., Jan. 7, 6 p.m.

Chemical Engineering Group

LONDON
"Explosions and Poisons: A Comparison of American and British Precautions," by J. H. F. Smith. Geological Society, Burlington House, Piccadilly, W.1. Tues., Jan. 10, 5.30 p.m.

Illuminating Engineering Society

LONDON
"Recent Developments in Photometry and Colorimetry," by G. T. Winch. Royal Society of Arts, John Adam-street, W.C.2. Tues., Jan. 10, 6 p.m.
BRISTOL
Various short papers on lighting installations. Bath and Bristol Centre. Royal Hotel, Bristol. Fri., Jan. 6, 7 p.m.
CARDIFF
"X-Rays in Medicine and Industry," by K. Rawlings. Cardiff Centre. Offices of the South Wales Electricity Board, The Hayes, Cardiff. Thurs., Jan. 5, 5.45 p.m.
GLASGOW
"Lighting Problems in the Coal Industry," by W. Rochester. Glasgow Centre. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. Thurs., Jan. 5, 6.30 p.m.
HULL
"Street Lighting," by J. J. French. Leeds Centre. Offices of the Yorkshire Electricity Board, Ferensway, Hull. Mon., Jan. 9, 7 p.m.

Incorporated Plant Engineers

LONDON
Debate: "That our Main Railways be Converted into Roads." Royal Society of Arts, John Adam-street, Adelphi, W.C.2. Tues., Jan. 3, 7 p.m.*
DUNDEE
"Hospital Services," by C. N. Anderson. Dundee Branch. Mathers Hotel, Dundee. Mon., Jan. 9, 7.30 p.m.
EDINBURGH
"Materials Handling," by J. Findlay. Edinburgh Branch. 25 Charlotte-square, Edinburgh. Tues., Jan 10, 7 p.m.
MANCHESTER
Discussion on "Power Factor Correction." Manchester Branch. Engineers' Club, Albert-square, Manchester. Tues., Jan. 10, 7.15 p.m.
PETERBOROUGH
Discussion on "Factory Flooring Problems." Peterborough Branch. Campbell Hotel, Bridge-street, Peterborough. Thurs., Jan. 5, 7.30 p.m.
SOUTHAMPTON
"Costing and Accountancy in Relation to Plant Engineering," by S. J. Clark. Southern Branch. Polygon Hotel, Southampton. Wed., Jan. 4, 7.30 p.m.

Institute of British Foundrymen

BRADFORD
"The Use of Refractories in the Foundry," by W. E. Ambler. West Riding of Yorkshire Branch. Technical College, Bradford. Sat., Jan. 7, 6.30 p.m.
MANCHESTER
"Practical Simple Costing in the Foundry," by G. Judd. Lancashire Branch. Midland Hotel, Manchester. Mon., Jan. 9, 7 p.m.

Institute of Fuel

LONDON
"Some Coal Research Problems and Their Industrial Implications," by R. L. Brown. Institution of Civil Engineers, Great George-street, S.W.1. Wed., Jan. 4, 5.30 p.m.*

Institute of Industrial Supervisors

GLASGOW
Annual General Meeting and Presidential Address. Glasgow Section. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. Mon., Jan. 9, 7.30 p.m.

Institute of Petroleum

LONDON
"Petroleum Fuels for Domestic Heating and Lighting," by G. F. J. Murray and D. F. Tompkins. Wed., Jan. 11, 5.30 p.m.*
ROCHESTER
Annual General Meeting and Film Display. South Eastern Branch. King's Head Hotel, Rochester. Tues., Jan 3, 7.30 p.m.

Institute of Refrigeration

LONDON
"Refrigeration Controls," by H. H. Egginton. Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, S.W.1. Thurs., Jan. 5, 5.30 p.m.*

Institute of Road Transport Engineers

BRISTOL
"Commer Two-Stroke Diesel Engines," by E. W. Coy. Western Centre. Royal Hotel, Bristol. Tues., Jan. 10, 7.30 p.m.
GLASGOW
"Gas Turbines and Their Application to Road Transport," by A. Enticknap. Scottish Centre. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. Mon., Jan. 9, 7.30 p.m.

Institute of Welding

LONDON
"Brittle Fracture of Mild Steel: A Survey," by Dr. Constance F. Tipper. North London Branch. Manson House, 26 Portland-place, W 1. Wed., Jan. 4, 7.30 p.m.*

Institution of Civil Engineers

LONDON
"Reconstruction of the Gallions Entrance Lock at the Royal Docks of the Port of London Authority," by J. A. Fisher. Maritime and Waterways Division. Tues., Jan. 3, 5.30 p.m.* "Consolidation of Ballast," by I. G. White. Railway Engineering Division. Tues., Jan. 10, 5.30 p.m.*

Institution of Electrical Engineers

LONDON
"Highland Water Power: The Development of the North of Scotland Hydro-Electric Board," by the late T. Lawrie. Thurs., Jan 5, 5.30 p.m.* "Power-Station Auxiliary Plant," by G. F. Kennedy and F. J. Hutchinson. Joint Meeting with the Institution of Mechanical Engineers. 1 Birdcage-walk, St. James's Park, S.W.1. Fri., Jan. 6, 5.30 p.m.*
GLASGOW
"Automatic Circuit Reclosers," by G. F. Peirson, A. H. Pollard and N. Care. South West Scotland Sub-Centre. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. Wed., Jan 4, 7 p.m.
LEEDS
"The Electrical-Engineering Industry in the Post-War Economy—II," by G. L. E. Metz. North Midland Centre. Yorkshire Electricity Board, 1 Whitehall-road, Leeds. Tues., Jan. 3, 6.30 p.m.
MANCHESTER
"Highland Water Power: The Development of the North of Scotland Hydro-Electric Board," by the late T. Lawrie. North Western Centre. Engineers' Club, Albert-square, Manchester. Tues., Jan. 3, 6.15 p.m.
NEWCASTLE-UPON-TYNE
"A Criterion of Distribution Cost," by D. J. Bolton. North Eastern Centre. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Mon., Jan. 9, 6.15 p.m.
PORTSMOUTH
"Receiving Aerials for British Television," by F. R. W. Strafford. Southern Centre. College of Technology Extension, Portsmouth. Wed., Jan. 4, 6.30 p.m.

Institution of Engineering Designers

NEWCASTLE-UPON-TYNE
"Thrust and Journal Bearings with Film Lubrication," by A. F. Wilson. North East Branch. Northern Architectural Association, 6 Higham-place, Newcastle-upon-Tyne. Mon., Jan. 9, 7.15 p.m.

Institution of Heating and Ventilating Engineers

BIRMINGHAM
"Mechanical Services in the British European Airways Hangars at London Airport," by L. Copeland Watts and J. W. J. Leslie. Birmingham Branch. Birmingham Exchange and Engineering Centre, Stephenson-place, Birmingham 2. Thurs., Jan. 5, 6.30 p.m.

Institution of Mechanical Engineers

LONDON
"Power-Station Auxiliary Plant," by G. F. Kennedy and F. J. Hutchinson. Joint Meeting with the Institution of Electrical Engineers. Fri., Jan. 6, 5.30 p.m.* "Overdrives and Their Control," by S. H. Ashby. Automobile Division. Tues., Jan. 10, 5.30 p.m.* "Instrumentation for Smoke Control in Small Boiler Plants," by A. E. Glaysher. London Graduates' Section. Wed., Jan 4, 6.30 p.m.
BEDFORD
"Hydraulic Transport of Solids," by R. C. Worster and Dr. D. F. Denny. Annual General Meeting. Eastern Branch. Dujon Restaurant, Bedford. Thurs., Jan. 12, 7.30 p.m.
LEICESTER
Annual General Meeting. Thomas Hawksley Lecture on "The Properties of Matter at High Pressures," by Professor D. M. Newitt. East Midlands Branch. College of Technology, Leicester. Tues., Jan 10. 6.30 p.m.

Institution of Production Engineers

COVENTRY
"Production of Piston Rings," by H. C. Blackford. Coventry Section. Craven Arms, High-street, Coventry. Tues., Jan. 10, 7 p.m.
LEEDS
"Automatic Inspection: The Anatomy of Conscious Machines," by J. A. Sargrove. Yorkshire Section. Hotel Metropole, King-street, Leeds, 1. Mon., Jan. 9, 7 p.m.
NOTTINGHAM
Informal Discussion Meeting. Nottingham Section. Victoria Station Hotel, Nottingham. Wed., Jan. 4, 7 p.m.
OXFORD
"Cost Accounting as an Aid to Efficient Production," by H. J. Furness. Oxford Section. Town Hall, Oxford. Tues., Jan. 3, 7.15 p.m.
SOUTHAMPTON
"Economic and Social Effects of Automation," by R. R. Williams. Southern Section. The University, Southampton. Thurs., Jan. 5, 7.30 p.m.
WOLVERHAMPTON
"Forgings and Pressings in High-Strength Aluminium Alloys," by J. E. Earl. Wolverhampton and Staffordshire Technical College, Wolverhampton. Wed., Jan. 4. 7.15 p.m.

Institution of Railway Signal Engineers

YORK
Open Meeting to be held jointly with the Permanent Way Institution. Railway Institute, York. Tues., Jan. 10, 5.30 p.m.*

Institution of Structural Engineers

LONDON
Discussion on "Engineering in Europe and America." London Graduates' and Students' Section. Wed., Jan. 4, 6.30 p.m. "The Application of an Electronic Digital Computer to Some Problems of Structural Analysis," by Dr. R. K. Livesley. Thurs., Jan. 12, 6.30 p.m.
BRISTOL
Open Meeting. Western Counties Branch. The University, Bristol. Fri., Jan. 6, 6 p.m.
NEWCASTLE-UPON-TYNE
Open Meeting. Northern Counties Branch. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Wed., Jan. 4, 6.30 p.m.

Institution of Works Managers

BIRMINGHAM
"Management as Seen from the Shop Floor," by L. Pridmore. Birmingham Branch. Birmingham Exchange and Engineering Centre, Stephenson-place, Birmingham. Tues., Jan. 10, 7 p.m.
MANCHESTER
"Educational Training for Industry," by Lady Simon of Wythenshawe. Manchester Branch. Grand Hotel, Manchester. Mon., Jan. 9, 6.45 p.m.

Junior Institution of Engineers

LONDON
Film Evening. Fri., Jan. 6, 7 p.m.
BIRMINGHAM
"Josiah Wedgwood: The Potter," by Miss R. J. Warne. Midland Section. James Watt Memorial Institute, Great Charles-street, Birmingham. Wed., Jan. 4, 7 p.m.
SHEFFIELD
"The Factory Acts," by D. E. Jones. Sheffield Section. Livesey Clegg House, Union-street, Sheffield. Mon., Jan. 9, 7.30 p.m.

Manchester Association of Engineers

MANCHESTER
"Polythene and Its Uses," by A. Renfrew. Engineers' Club, Albert-square, Manchester. Fri., Jan. 6, 6.45 p.m.

North East Coast Institution of Engineers and Shipbuilders

NEWCASTLE-UPON-TYNE
"Steel for Shipbuilding," by T. F. Pearson. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Fri., Jan. 13, 6.15 p.m.

Reinforced Concrete Association

LIVERPOOL
"Selection and Grading of Aggregates for Various Types of Concrete Works," by J. D. McIntosh. North Western Branch. Liverpool Engineering Society, 9 The Temple, 24 Dale-street, Liverpool. Wed., Jan. 4, 6.30 p.m.*
MANCHESTER
"Selection and Grading of Aggregates for Various Types of Concrete Works," by J. D. McIntosh. North Western Branch. College of Technology, Sackville-street, Manchester. Tues., Jan. 3, 6.45 p.m.*

Royal Aeronautical Society

LONDON
"Test Flying: Current Problems and Techniques," by Wing Commander R. P. Beamont. Young People's Lecture. Institution of Civil Engineers, Great George-street, S W.1. Thurs., Jan. 5, 3 p.m. (Tea at 4.30 p.m.) "Some Modern Structural Problems," by Professor W. S. Hemp. Tues., Jan. 10, 7 p.m.

Royal Society for the Promotion of Health

LONDON
"Housing Repairs and the Rent Acts," by J. Clancey, at 10.30 a.m. "Slum Clearance," by Major D. J. E. Lamb; and "Grants for Improvements and Conversions," by J. E. Austin, at 2 p.m. Caxton Hall, S.W.1. Wed., Jan. 11.

Sheffield Metallurgical Association

SHEFFIELD
Annual General Meeting of the Methods of Analysis Group, 6.30 p.m. "The Use of Statistical Design in Chemical Analysis," by G. A. Coutie, 7 p.m. B.I.S.R.A. Laboratories, Hoyle-street, Sheffield, 3. Tues., Jan 10.

Society of Instrument Technology

LONDON
"Liquid-Flow Control," by B. W. Balls. Control Section. 26 Portland-place, W.1. Thurs., Jan. 12, 7 p.m.*

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

* An asterisk is placed where it is understood that tea is available prior to the time stated.

Aslib (Association of Special Libraries and Information Bureaux), 4 Palace-gate, London, W.8. (WEStern 6321.)
British Institution of Radio Engineers, 9 Bedford-square, London, W.C.1. (MUSeum 1901.)
British Interplanetary Society, 12 Bessborough-gardens, London, S.W.1.
Chemical Engineering Group, 56 Victoria-street, London, S.W.1. (VICtoria 6161.)
Illuminating Engineering Society, 32 Victoria-street, London, S.W.1. (ABBey 5215.)
Incorporated Plant Engineers, 48 Drury-lane, Solihull, Birmingham. (Solihull 3021.)
Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester 3. (Blackfriars 6178.)
Institute of Fuel, 18 Devonshire-street, Portland-place, London, W.1. (LANgham 7124.)
Institute of Industrial Supervisors, 24 Albert-street, Birmingham 4. (Midland 6971.)
Institute of Petroleum, Manson House, 26 Portland-place, London, W.1. (LANgham 2250.)
Institute of Refrigeration, Dalmeny House, Monument-street, London, E.C.3. (MINcing Lane 6851.)
Institute of Road Transport Engineers, 69 Victoria-street, London, S.W.1. (ABBey 6248.)
Institute of Welding, 2 Buckingham Palace-gardens, London, S.W.1. (SLOane 9851.)
Institution of Civil Engineers, Great George-street, London, S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. (TEMple Bar 7676.)
Institution of Engineering Designers, 38 Portland-place, London, W.1. (LANgham 8847.)
Institution of Heating and Ventilating Engineers, 49 Cadogan-square, Lonon, S.W.1. (SLOane 3158.)
Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. (WHItehall 7476.)
Institution of Production Engineers, 10 Chesterfield-street, London, W.1. (GROsvenor 5254.)
Institution of Railway Signal Engineers, Euston House, Eversholt-street, London, N.W.1.
Institution of Structural Engineers, 11 Upper Belgrave-street, London, S.W.1. (SLOane 7128.)
Institution of Works Managers, 67-68 Chandos-place, London, W.C.2. (TEMple Bar 8324.)
Junior Institution of Engineers, Pepys House, 14 Rochester-row, London, S.W.1. (VICtoria 0786.)
Manchester Association of Engineers, 18 Booth-street, Manchester 2. (Central 1717.)
North East Coast Institution of Engineers and Shipbuilders, Bolbec Hall, Newcastle-upon-Tyne, 1. (Newcastle 20289.)
Reinforced Concrete Association, 94-98 Petty France, London, S.W.1. (ABBey 4504.)
Royal Aeronautical Society, 4 Hamilton-place, London, W.1. (GROsvenor 3515.)
Royal Society for the Promotion of Health, 90 Buckingham Palace-road, London, S.W.1. (SLOane 5134.)
Sheffield Metallurgical Association, 15 Crescent-road, Sheffield 7. (Sheffield 53674.)
Society of Instrument Technology, 184 Sherwood Park-road, Mitcham, Surrey. (POLlards 3620.)

In Parliament

TECHNICAL EDUCATION PLANS

Demands that technical and higher technological education in Britain should be further and more rapidly developed were pressed forward in a recent series of questions put to Sir David Eccles, the Minister of Education. In a preliminary answer, Sir David told the House that he hoped to make a statement soon about his plans for improving and expanding the education given in technical colleges in England and Wales.

He agreed with Mr. E. G. M. Fletcher (Labour), who had put a supplementary question emphasising the need for laying the foundation for a technical education in the schools, that it was absolutely essential to see that students coming forward for technical education were properly prepared. Mr. Fletcher also pointed out that, if the deficiencies in technological education were to be made good, it was not going to be sufficient merely to open some more technical colleges, but it would be necessary to provide further opportunities for teaching science in schools, by making more attractive provision for science teachers and by providing schools with better scientific equipment.

Mr. Geoffrey de Freitas (Labour) inquired whether the Minister was aware that there was already a shortage of technicians in the aircraft industry which was prejudicing the design of aircraft and aero-engines, and whether he would tackle this question as soon as he could in the new schools, because that was the key to whole problem. Sir David answered in the affirmative.

PROGRESS OF HIVES COUNCIL

Mr. Austen Albu (Labour) congratulated the Minister on the very strong council which he had appointed in connection with the new diploma in technology, but suggested that the time which had elapsed since his original appointment of Lord Hives had been excessive, and inquired whether a report might be expected very shortly. He also asked whether the council's terms of reference would include power to make recommendations for establishing a number of regional colleges and for their financial requirements.

Sir David said that great care had been taken to get the best men on the council and that that body would meet for the first time on December 19. He would deal with the question of regional colleges when he made his full statement. Asked by Mr. Albu about the large number of potential students for training as technicians and technologists who were being lost, owing to the gap in the educational provision for juveniles leaving school at the age of 15, Sir David said it should be remembered that the number of young people taking part-time courses was constantly increasing. He agreed that special steps should be taken to see that the wastage declined.

In answer to a question by Mr. A. W. J. Lewis (Labour), Sir David said he had recently received deputations from the Association of Teachers in Technical Institutions and the Association of Heads of Secondary Technical Schools. He had been able to assure them that he was largely in agreement with their views on the needs of technical colleges and secondary technical schools. On September 30, there were 41 projects for the provision of secondary technical schools in hand, and a further 64 projects had been approved.

CLOSURE OF BRANCH RAILWAYS

A motion complaining about the closure of the Halifax, Bradford and Keighley railway to passenger traffic was moved by Mr. Geoffrey Hirst (Unionist), who gave the House details of the inconveniences to local inhabitants caused by the closing of this branch line, of the difficulties and insufficiencies of the alternate means of transport, and of his efforts to obtain redress. He was supported by Mr. C. R. Hobson (Labour), who seconded the motion, Captain J. A. L. Duncan (National Liberal and Unionist), and others.

Mr. R. Gresham Cooke, C.B.E. (Unionist) said that Parliament had asked the British Transport Commission to pay its way, taking one year with another, and it was unfair, therefore, to oppose the Commission when it sought to make economies. Where there was insufficient traffic, the Commission must close the line and Parliament must agree. It might be possible, by the use of light Diesel buses on the rails, to degrade some branch lines to a kind of tramway operation. He understood that it cost between £7,000 and £8,000 to place a Diesel bus on a railway line, and that was not a very heavy capital expenditure. They could be operated by one driver and, possibly, a conductor, to collect the fares. Such a system was much cheaper than having to maintain signalling systems, level crossings, station porters and other staff. A Diesel train cost about 13*d.* a mile to operate, whereas a steam train cost about 37*d.* a mile.

The Joint Parliamentary Secretary to the Ministry of Transport and Civil Aviation, Mr. Hugh Molson, said that the question of what services were run and what branch lines were kept open was a matter that had been entrusted by the Transport Act of 1947 to the Commission and not to the Minister of Transport. The Commission was anxious to develop the use of Diesel cars wherever there was potential traffic, but, even so, in the case of the small branch line in question, there was no chance of making it pay. The total cost of the service over a recent period was £56,939 against receipts of only £8,113.

In the Commission's modernisation plan it had been made plain that British Railways would aim at expanding their great natural advantages as bulk and long-distance carriers of passengers and goods, gradually transferring to the roads traffic more suited to that means of transport. It would be completely inconsistent with this general principle for the Government to seek to compel the Commission to keep open unprofitable lines. As a result of increased costs, and the decrease in revenue arising out of the railway strike, there was little doubt that this year's deficit would be substantially in excess of the £25 million already forecast. While many of the benefits anticipated by the Commission from the plan would begin to accrue before the 15 years mentioned had passed, it had always been certain that they would not accrue to any great extent in the first few years. The debate was adjourned.

Opencast Coal-Mining Sites

Mr. John George (Unionist) was informed by Mr. Geoffrey Lloyd, the Minister of Fuel and Power, that most of the proposals of the National Coal Board for working opencast coal-mining sites had been approved. There were, however, 41 fully-prospected sites and certain partially-proved areas, estimated to contain at least eight million tons of coal, which had not been worked for agricultural or amenity reasons.

Expenditure on Aircraft Prototypes

Mr. George Wigg (Labour) supplied a list of 56 aircraft to the Minister of Supply and asked, in a written question, for the full cost, including development expenditure and cost of prototypes, of these machines. He also inquired how many of each type were ordered ; the date when the order for each aircraft was placed; how many of each type were delivered; how long they were in service; how many of each type crashed; and how many of each type were still capable of flying.

The Parliamentary Secretary to the Ministry of Supply, Mr. F. J. Erroll, replied that the majority of these aircraft were prototypes ordered for research purposes and never intended to go into service. It would be contrary to established practice to disclose the cost of individual research projects, but a rough estimate of the total airframe cost involved in the development of these types was £40 million. He did not think that the work involved in collating the detailed information asked for in the other parts of the question would be justified.

Fireproof Materials in Civil Aircraft

Sir Alfred Bossom, Bt. (Unionist) asked the Minister of Transport and Civil Aviation to what extent combustible material used in passenger-carrying aircraft was required, under his regulations, to be fireproof, as was required for all material used in tall buildings over a certain height.

In reply, Mr. John Boyd-Carpenter said that materials used in the construction of modern civil aircraft were required to conform to British civil airworthiness requirements. These specified that sources of fire, such as engine nacelles, should be isolated from the main structure and the cabin by fire walls; that material used in the construction of fire walls and in the fire zones themselves should be fireproof to the extent that it was resistant to the application of a hot flame for a prescribed period; and that material used in other parts of the aircraft, such as cabin furnishings, should be flameproof to the extent that it was not easily ignited and would not propagate combustion. In addition, all such materials were required to conform to specifications approved by the Air Registration Board, and resistance to fire was one of the properties specified.

Use of Railway Workshops

Mr. Boyd-Carpenter replied in the negative to a question by Mr. D. T. Jones (Labour) as to whether he would give a general direction to the British Transport Commission that railway workshops should always be used to capacity for work which they were capable of doing, in view of the threat of dislocation in these workshops caused by the Commission's decision to order locomotives required for its modernisation programme from outside firms.

The Minister added that the Commission had made it clear in its announcement on November 22 that its present orders for Diesel locomotives referred to pilot models for trial purposes, and that these orders should not be taken as an indication of permanent policy. Such policy would be discussed with the unions concerned through the joint consultative machinery.

Liverpool Overhead Railway

In answer to a question by Mr. D. G. Logan, C.B.E. (Labour), Mr. Boyd-Carpenter said that he had recently seen a deputation on the subject of the future of the Liverpool Overhead Railway, which included, among others, representatives of the Liverpool City Council. He had informed the deputation that, as this matter was shortly to come before Parliament as the result of the promotion of a Private Bill by the proprietors of the railway, he did not feel that it would be appropriate for him to take any action at this stage.

New Bridge at Linlithgow

Mr. J. Taylor (Labour) was informed by Mr. Boyd-Carpenter that it was hoped that a start would be made next spring on the erection of the new bridge over the River Avon at Linlithgow, on road A9.

Trials of Radar for Small Ships

Asked by Mr. Hector Hughes (Labour) regarding trials at Fraserburgh and Arbroath of inexpensive new radar apparatus for guiding small vessels into harbour when visibility is bad, Mr. Boyd-Carpenter stated that these trials were made under operational conditions between a prototype transmitter on shore and fishing vessels, fitted with prototype receivers, at sea. They were attended by representatives of four fishermen's associations and of nine radio manufacturers. The apparatus was not yet on the market, but it was understood that the manufacturers were actively studying the question of commercial production. Details of the design were available from the Ministry of Transport and Civil Aviation without charge.

THE HUMAN ELEMENT

Trade-union leader attacks productivity as a means to higher wages—Police and Local Government salaries raised at last—A giant stirs, the T.G.W.U. to press for redistribution of the national income?—Trade disputes and church intervention, Rolls-Royce strike ended—Party advocates of co-partnership.

★ ★ ★

Stones in a Glasshouse

Several unions have gone out of their way to make it quite clear that they do not consider that their duty to their members is merely to keep wages in line with the cost of living and let wage rates go up only with productivity. This is obviously the attitude of the T.G.W.U. which is dealt with in another note. It is also the point of view of the Amalgamated Union of Foundry Workers to judge from a recent pronouncement of their general secretary. In a statement recently, he attacked the T.U.C's effort to relate wage increases to increased output.

Mr. Gardner's view is that increases in productivity have gone to increase profits and dividends while real wages have fallen. He has not, it is clear, looked with any care at the national income statistics for the years since the war or he would have seen that he is quite wrong and that there has been a notable shift in the distribution of the national income in favour of the wage earners. But his bad economics are of less significance than his emotional attitude to the situation and the fact that he will have nothing to do with productivity. Yet it must be clear to even the least thoughtful that fewer goods made means less to go round, and stones thrown at productivity are likely to crack a few panes in everybody's standard of living.

It is clear that the few last strands which bind the trade union movement to a policy of wage restraint are fast wearing through. This may be one of the critical developments in trade-union thinking in the early months of 1956. If that should be so, the employers will have to take account of it and cease living in the negotiating atmosphere of the early 1950's.

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Belated Salary Awards

Local Government Officers and Police Officers have been granted increases in their salaries under arbitration awards announced last week. About 175,000 Local Government Officers are to receive a 5 per cent. increase from January 1, "in view of recent rises in prices, industrial wages and Civil Service pay." There will also be improvements in subsistence allowances, and it is recommended that wherever possible the 38 hour week will be worked in 5 days. The awards to the Police affect nearly 70,000 officers, and range from £30 to £130 a year. They amount to an increase of 16·4 per cent. at the maximum of the various pay scales, which is about half the increase asked for by the Police Federation.

Police pay has been allowed to slip back to a dangerously low level since the war. At present, a constable's pay ranges from £445 to £555 a year, not much more than a senior shorthand-typist and considerably less than the average earnings of workers in the motor industry. Public servants, whether Local Government Officers or Police Officers, are expected to serve with faithful loyalty and to remain quite incorruptible. The danger of paying them less than the mass of workers in the country is too obvious to comment upon. The relatively low pay is probably the most valid reason for the lamentable conduct of men and women in the employ of the Government and the Police in a large number of foreign countries, who look upon our high standards in this field with envy. Such a position should not be lightly sacrificed and the public should see to it that the Government and Police Officers are adequately rewarded to perform the duties which are expected of them.

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The T.G.W.U. Rampant?

When a giant stirs, it is time to take due note. There have been signs of late that the Transport and General Workers' Union is going to adopt a less conciliatory attitude on wage claims. The union issued a somewhat equivocal statement earlier this month about wage claims in general and last week it put forward a wage demand with other unions on behalf of the dockers which involves some 100,000 men.

The British Employers' Confederation has issued a statement chiding the union for its attitude. Doubtless the attitude of the Confederation is conditioned by its recent offer to discuss wages policy with the T.U.C. and other bodies with special reference to price stabilisation The resulting gap in points of view (the tidy minded would probably call it a confusion of timing) is typical of what can happen when a body of industrial diplomats take a broad policy view while trade-union representatives are mindful that they are paid to raise the pay packets of their members.

The B.E.C. statement does, however, emphasise once again the gap which exists in basic thinking between the employers and the unions on wage policy. The employers start from the point that there is a fair and reasonable share which labour can take out of the proceeds, based on present shares—it is the philosophy of a little less and a little more.

The union men are determined in many cases to bring about a permanent change in the basic shares. They foresee a shift in the distribution of the national income in favour of the operatives. Given this attitude on the part of labour, the B.E.C's sweetly reasonable remarks about the T.G.W.U. wanting to take more of the national income than at present are not going to startle the men of Smith Square, or make them feel ashamed. The real question is: how far will they go to get it?

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Back at Work

The strike at the Scottish factories of Rolls-Royce has fizzled out and left much bitterness in its train. The Scots feel that the English have let them down, and the English that the Scots have asked for too much too near Christmas. This has been a most unfortunate affair and is unlikely to be allowed to rest there. It has ended in a victory for the firm, but the cost to all concerned has been heavy and the unions have been unanimous in saying that the issues raised by the dispute are too important to the trade union movement to be dropped in this manner. The men lost over half a million pounds in wages, and the company infinitely more in the loss of production of jet aero engines.

The A.E.U., who have been principally concerned although they did not initiate the stoppage, called it off in view of "the absence of 100 per cent. trade unionism in the Rolls-Royce factories as a whole and the lack of effective support from the workers in the other factories." They have recommended a detailed examination of trade-union organisation in all Rolls-Royce factories and that a campaign should be initiated to "urge all the workers to the viewpoint of joining their appropriate trade union."

The most important aspect of this strike has been the intervention of the Roman Catholic Church on behalf of one of its members, Mr. J. McLernon, over whose alleged breach of agreement to limit piecework earnings in a slack period the strike began. This is a new development in British trade unionism and one which might have far-reaching consequences. A member of the Church, Mr. W. J. Carron, is the favourite for winning the election to the Presidency of the A.E.U. in opposition to a Communist candidate, Mr. R. Birch. The Rolls-Royce conflict and the Catholic intervention is lilely to accelerate the trend towards a sharper division between "right" and "left" in the trade-union movement. It is the movement which could well be the loser in the end.

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Exit Monckton—Enter Monckskell?

Since this is the season of party games there is no harm in trying one more hybrid name, this time at the expense of Sir Walter Monckton and Mr. Gaitskell. Sir Walter has left the Ministry of Labour and his going will be genuinely regretted by both sides of industry. His stay has not been an easy one and his role has been conciliatory rather than one of bold and scintillating originality. Perhaps it has been better so. In his closing months of office he has had a good deal to say about co-partnership as part of the solution for industry's problems of human relations.

In his closing days at the Ministry he has gained an unexpected ally—or so it would seem from a recent speech given at Cleckheaton in Yorkshire. In his speech there, immediately after becoming leader of the Labour Party, Mr. Gaitskell called for a better relationship between workers and management. A far greater sense of participation and partnership was desirable though, he hastened to add, this was all a matter mainly for the trade-union side of the labour movement. His words will have to be clothed with further explanation before their full meaning is clear, but it is of interest that Mr. Gaitskell has chosen to talk about methods of industrial conciliation in the flush of victory.

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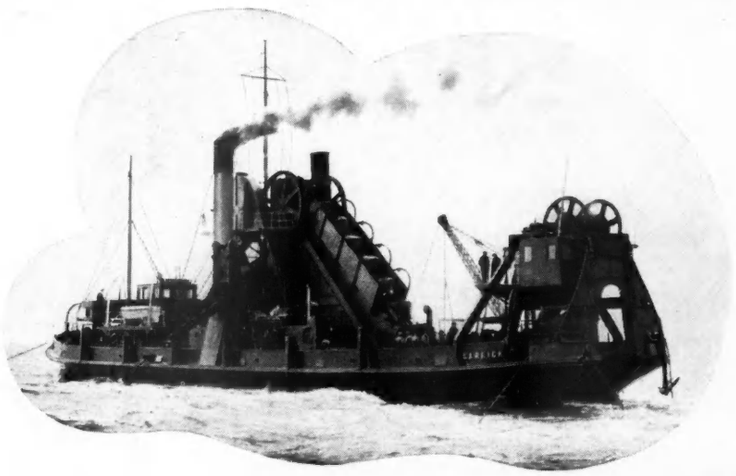

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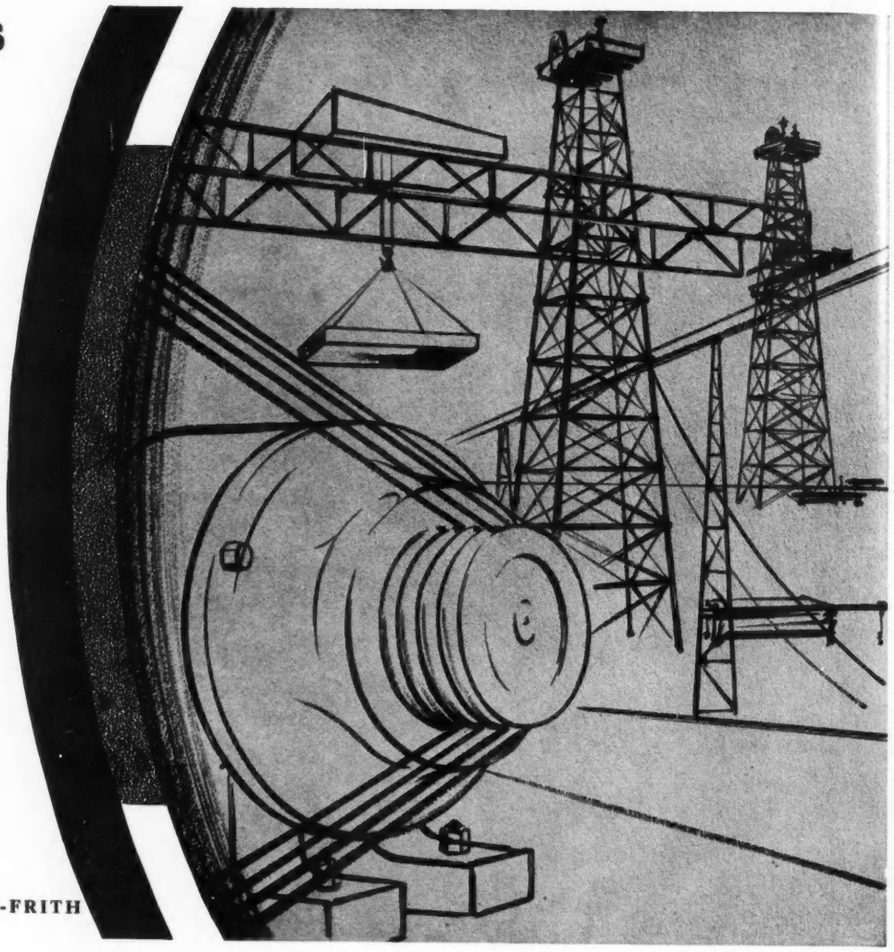

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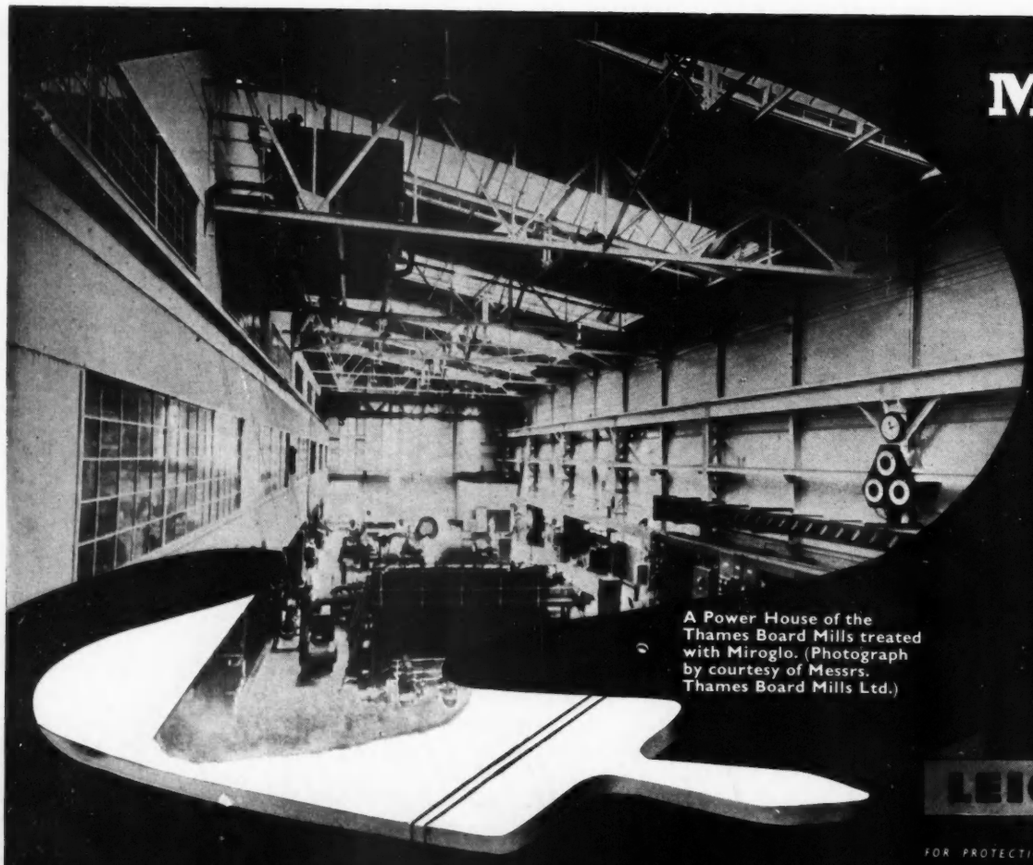

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ROBERT RILEY, LTD MILKSTONE SPRING WORKS, ROCHDALE. 'Phone: ROCHDALE 2237 (5 Lines) 'Grams: "RILOSPRING," ROCHDALE

CLASSIFIED ADVERTISEMENTS SECTION.

For all advertisements classified under the headings of Tenders, Appointments Open, Situations Wanted, Patent Agents, Partnerships, Wanted, &c., Auction Sales, Publications For Sale, Miscellaneous and Public Notices, &c., the charge will be 12s. for the first four lines or under and 3s. per line up to one inch. When an advertisement measures an inch or more, the charge will be at the rate of 36s. per inch. 5% allowed on 6, 10% on 13, 15% on 26 and 20% on 52 Weekly insertions. If use is made of a box number the extra charge is 2s. per insertion with the exception of advertisements appearing under Situations Wanted. Prospectuses and Notices of Company Meetings £25 per column. Copy instructions must be in our hands first post Monday for the following Friday's issue. Address to the Manager, ENGINEERING LTD., 35 and 36, Bedford St., Strand, W.C.2. Inclusion of advertisements must be dependent on space being available.

EDUCATIONAL.

FREE, Brochure giving details of courses in Mechanical and Production Engineering, Draughtsmanship, etc., for the A.M.I.Mech.E., A.M.I.P.E., City and Guilds and other Professional examinations. E.M.I. INSTITUTES, DEPT. EG. 30, LONDON, W.4. (ASSOCIATED WITH H.M.V.). G 560

EXPERIMENTAL WORK.

RESEARCH ENGINEERS LIMITED,

Northampton Grove, Canonbury, London, N.1. Canonbury 4244/5/6. We have over 25 years' experience of experimental work and prototypes. We design, develop and manufacture special purpose and labour saving machines, all at the above address. Our range is from the smallest scientific instruments to 3- or 4-ton machines. After a prototype machine has been made and found satisfactory we can manufacture as many as are required in our Works. G 456

TENDERS.

CHELTENHAM AND GLOUCESTER JOINT WATER BOARD.

SALE OF BOILERS, STEAM PUMPS AND ANCILLARY EQUIPMENT, AT MYTHE WATERWORKS, TEWKESBURY.

OFFERS are invited for the following:—

ITEM I.

(A) TWO LANCASHIRE BOILERS fitted with Superheaters, Economisers and modern Bennis Air Draught Stokers.

(B) WORTHINGTON-SIMPSON PUMP ENGINE, partly dismantled.

(C) HATHORN PUMP ENGINE, partly dismantled.

STEEL LADDERS, gantry crane and chequer plating are not for sale.

ITEM II.

GANTRY CRANE, Span 38 ft. 4 ins., safe working load 5½ tons.

Further information and permission to view may be obtained on application to the undersigned.

Offers endorsed "Machinery" and addressed to the CLERK TO THE BOARD, must be received not later than noon 2nd January, 1956.

G. GOULD MARSLAND, M.B.E., B.Sc., M.Inst.C.E.,
J. H. GOODRIDGE, A.M.Inst.C.E., A.M.Inst.W.E.
JOINT ENGINEERS.

MUNICIPAL OFFICES, CHELTENHAM. J 607

INDIAN RAILWAYS' requirements against Rolling Stock Global Procurement Programme, 1956-57: **STEAM BREAKDOWN CRANES.**

THE HIGH COMMISSIONER FOR INDIA invites **TENDERS** for the supply of:—

			Quantity.
STEAM BREAKDOWN CRANES:—			Nos.
BROAD GAUGE			
5 ft. 6 in.	To lift 75 tons	... ...	2
Ditto.	To lift 20 tons	... ...	6
Ditto.	To lift 10 tons	... ...	14
Ditto.	To lift 5 tons	... ...	8
Ditto.	To lift 3 tons (hand operated)		3
Ditto.	To lift 30 tons	... ...	2
METRE GAUGE:—			
3 ft. 3⅜ in.	To lift 35 tons	... ...	4
Ditto.	To lift 15 tons	... ...	3
Ditto.	To lift 5 tons	... ...	7
Ditto.	To lift 10 tons	... ...	33
Ditto.	To lift 5 tons (hand operated)		5

Forms of tender may be obtained from the DIRECTOR GENERAL, INDIA STORE DEPARTMENT, GOVERNMENT BUILDING, BROMYARD AVENUE, ACTON, LONDON, W.3, on or after the 30th December, 1955, at a fee of 10s., which is not returnable. If payment is made by cheque, it should please be made payable to the "HIGH COMMISSIONER FOR INDIA." Particular Specifications are also available for sale from the same address. Drawings numbered 5120 and 5121 will be exhibited at the offices of Messrs. Hodges and Bennett & Co., Ltd., 59/60 Petty France, Westminster, London, S.W.1, from whom copies may be purchased by firms tendering. Drawing No. L.369 is incorporated in the Particular Specification No. CR.7/55. I.R.S. Specifications cited in the Particular Specifications are available for sale at the INDIA HOUSE, PUBLICATIONS BRANCH, ALDWYCH, LONDON, W.C.2. Tenders are to be delivered by 2 p.m. on Friday, the 10th February, 1956, to the DIRECTOR GENERAL, INDIA STORE DEPARTMENT, LONDON.

Please quote reference number 250/55/DH/RLY. J 720

LINDSEY COUNTY COUNCIL.
KESTEVEN COUNTY COUNCIL.

HIGHWAYS DEPARTMENT.

ALTERATIONS TO BARDNEY JOINT BRIDGE B.1190.

TENDERS are invited for the construction of **NEW PORTAL FRAME, R.C. ABUTMENTS AND FOR THE PROVISION OF A NEW WELDED STEEL DECK TO BARDNEY BRIDGE,** which is a 100 ft. span lattice girder bridge over the River Witham 10 miles east of Lincoln.

The drawings and Contract Documents may be seen either in the office of the County Surveyor, Lindsey County Council, or at the office of the Consulting Engineers, Messrs. Wilton & Bell, 25, Victoria Street, Westminster, S.W.1, and copies of all the Contract Documents and drawings may be obtained from the Consulting Engineers at 25, Victoria Street, Westminster, S.W.1, on payment of a deposit of £3, which will be returnable on receipt of a bona fide tender.

The documents will be available as from the 28th December.

Tenders to the undersigned by 10 a.m. on 27th January, 1956, in a sealed envelope marked "BARDNEY JOINT BRIDGE."

The Council do not bind themselves to accept the lowest or any tender.

C. K. TALLACK, A.M.I.C.E., COUNTY SURVEYOR.

COUNTY OFFICES, LINCOLN. J 710

ELECTRICITY SUPPLY BOARD, EIRE.
STEAM STATION AT RHODE, CO. OFFALY.

THE ELECTRICITY SUPPLY BOARD invites **TENDERS** for the civil construction work for a proposed power station at Rhode, Co. Offaly, to house two 20,000-kW turbo-generators and two boilers, each 210,000 lb. steam per hour M.C.R. capacity.

The work comprises generally:—

SECTION 1: **THE CONSTRUCTION OF POWER STATION BUILDINGS,** comprising boiler house, engine room, workshop, offices and ancillary buildings and general site development.

SECTION 2: **THE CONSTRUCTION OF A REINFORCED CONCRETE HYBERBOLIC TYPE COOLING TOWER,** approximately 260 ft. high and 200 ft. diameter at ground level.

CONTRACTORS MAY TENDER FOR EITHER OR BOTH OF THE ABOVE SECTIONS.

Forms of tender, general conditions of contract, specification, schedule of quantities and drawings may be obtained from the BOARD'S CHIEF ENGINEER, CIVIL WORKS DEPARTMENT, 21, LR. FITZWILLIAM STREET, DUBLIN, for either section 1 or section 2 on deposit of £26 5s. 0d. (twenty-five guineas) or for both sections 1 and 2 on deposit of £52 10s. 0d. (fifty guineas). These deposits will be returned on receipt of a *bona-fide* tender not subsequently withdrawn. Additional copies of the contract documents for either section may be obtained on payment of £10 10s. 0d. (ten guineas), which will not be returnable.

Sealed tenders endorsed "Tender—Rhode Power Station" must be lodged with the undersigned not later than twelve o'clock noon on Monday, 5th March, 1956.

The Board does not bind itself to accept the lowest or any tender.

PATRICK J. DEMPSEY, SECRETARY.

ELECTRICITY SUPPLY BOARD, 27, LOWER FITZWILLIAM STREET, DUBLIN. J 729

PUBLIC APPOINTMENTS.

CENTRAL ELECTRICITY AUTHORITY require **THIRD ASSISTANT ENGINEER (BOILER PLANT)** in the Plant Design Sub-Branch at Headquarters in London, to assist in technical and economic investigations in relation to boiler plant and ancillary equipment. Candidates should have an engineering degree or equivalent qualification and experience in the manufacture of major items of power station mechanical plant, preferably those associated with boilers. Salary within N.J.B. Grade 3, £908–£1125 p.a. inclusive.

Application forms from D. MOFFAT, DIRECTOR OF ESTABLISHMENTS, WINSLEY STREET, LONDON, W.1, to be completed and returned not later than 15th January, 1956. Quote Ref. AE/722. J 713

LONDON ELECTRICITY BOARD.

STRUCTURAL ASSISTANTS AND STRUCTURAL DRAUGHTSMEN.

Applications are invited for the above positions in the Construction Branch of the Chief Engineer's Department in Central London.

Applicants for the positions of Structural Assistants in the Civil Engineer's Section should be experienced in the design and detailing of reinforced concrete and/or steel framed superstructures and foundations.

Applicants for the positions of Structural Draughtsman should have a knowledge of building construction requirements and/or some experience in detailing reinforced concrete or steel structures.

The posts are graded under Schedule "D," National Joint Board agreement, as Grade 5 £672 to £777 and Grade 6 £535 10s. to £661 10s. per annum respectively, inclusive of London Allowance. Commencing salaries will be dependent on qualifications and experience.

Application forms obtainable from PERSONNEL OFFICER, 46/47, NEW BROAD STREET, LONDON, E.C.2. Please quote ref. V/2003/FF. J714

CENTRAL ELECTRICITY AUTHORITY.

EASTERN DIVISION.

Applications are invited for the following appointment in the Generation (Construction) Department at Divisional Headquarters:—

SENIOR DRAUGHTSMAN (MECHANICAL).

Salary Schedule "D," Grade 4, £787 by £20 to £892 per annum.

The commencing salary will depend upon experience and qualifications. Applicants should preferably have experience in Generating Station plant layout and design of pipework, coal, ash and dust handling systems, etc.

Applications statin age, qualifications and experience should be sent to THE CONTROLLER, CENTRAL ELECTRICITY AUTHORITY, EASTERN DIVISION, NORTHMET HOUSE, SOUTHGATE, N.14.

W. N. C. CLINCH, CONTROLLER. G 563

CENTRAL ELECTRICITY AUTHORITY.

EASTERN DIVISION.

Applications are invited for the following appointment in the Generation (Construction) Department at Divisional Headquarters in North London:—

CIVIL AND STRUCTURAL DESIGNER DRAUGHTSMAN.

Salary: N.J.B., Schedule "D," Grade 4, £787 by £20 to £892 per annum.

The commencing salary will depend on experience and qualifications.

The candidate appointed will be required to undertake civil and structural design work, and applicants should have had experience in the design and detailing of reinforced concrete structures for heavy plant, culverts, etc., and structural steelwork as applied to industrial buildings.

Applications stating age, qualifications and experience should be sent to THE CONTROLLER, CENTRAL ELECTRICITY AUTHORITY, EASTERN DIVISION, NORTHMET HOUSE, SOUTHGATE, N.14.

W. N. C. CLINCH, CONTROLLER. G 582

BRITISH RAILWAYS,

CHIEF CIVIL ENGINEER'S OFFICE, WESTERN REGION, PADDINGTON STATION, LONDON, W.2.

SENIOR ENGINEERING ASSISTANT experienced in design of R.C. and prestressed concrete bridges, competent to take charge in Drawing Office. Post offers permanency, opportunities for promotion and carries superannuation and rail travel privileges.—Apply giving age, experience and qualifications to CHIEF CIVIL ENGINEER. J 687

NOTTINGHAM AND DISTRICT TECHNICAL COLLEGE.

Principal: D. A. R. CLARK, M.Sc.(Tech.), M.I.Mech.E.

Applications are invited for the post of **ASSISTANT GRADE B IN MECHANICAL ENGINEERING,** to teach subjects to the H.N.C. or Degree standard.

Salary: £525 by £25 to £820 per annum, with allowances for training and approved industrial experience.

Application forms and further particulars may be obtained from the REGISTRAR, NOTTINGHAM AND DISTRICT TECHNICAL COLLEGE, SHAKESPEARE STREET, NOTTINGHAM, to whom completed forms should be returned not later than 11th January, 1956.

F. STEPHENSON, Clerk to the Joint Education Committee. J 702

LONDON COUNTY COUNCIL.

Vacancies for

GRADE II ASSISTANTS in the DISTRICT SURVEYORS' SERVICE (salary £945 to £1134, with starting point according to experience and qualifications). Duties will include the supervision of works in progress and checking of calculations. Qualifications: A.R.I.B.A., A.M.I.Str.E., or A.R.I.C.S., structural knowledge essential.

Particulars and application form from ARCHITECT (AR/EK/DS/2), THE COUNTY HALL, S.E.1. (2122) J 718

AIR MINISTRY require

CIVIL ENGINEERS in Works Department for engineering and administrative work on construction and maintenance of civil engineering and building projects (covering barracks, workshops, runways, roads, water supply, sewage, drainage works, etc.) on R.A.F. and Civil Aviation stations. Appointments carry liability for service overseas in two grades: (*a*) **Main Grade,** starting salary £1180 to £1525 p.a.; (*b*) **Assistant Grade,** starting salary at age 25, £760 to £1045 at age 34 to £1180 p.a.; in addition an increase of £74 p.a. (within the maximum of the salary scale) after two years approved service subject to age then being 27 years or over and corporate membership of the Institution of Civil Engineers being held. Salaries somewhat lower in provinces. Lodging allowance payable in certain circumstances for appointments in Assistant Grade. A special allowance of up to £1500 a year according to location is payable in addition to salary during overseas service. Appointments temporary but have long-term possibilities. Five weeks paid leave annually (six weeks after three years service). Qualifications: natural born British subjects and for Main Grade MUST be corporate members of the Institution of Civil Engineers or Institution of Municipal Engineers, degree in civil engineering would be an advantage. For Assistant Grade should hold one of the following: B.Sc.(**Eng.**) or equivalent, A.M.I.C.E., or A.M.I. Mun.E., or **Parts** I and II of the Institution of Civil Engineers or the Testamur of the Institution of Municipal Engineers and should have at least two years civil engineering experience on staff of Government Department, Local Authority, or firm of Consulting Engineers or Contractors of good standing. Initial appointments to locations at or nearest to those specified by applicants arranged as far as possible.—Application forms quoting reference E/2/5/A for Main Grade and E/3/5/A for Assistant Grade from M.L.N.S., TECHNICAL AND SCIENTIFIC REGISTER (K), ALMACK HOUSE, 26, KING STREET, LONDON, S.W.1. J 375

UNIVERSITY OF EDINBURGH.

Applications are invited for

I.C.I. RESEARCH FELLOWSHIPS IN BIOCHEMISTRY, CHEMISTRY, ENGINEERING, PHARMACOLOGY, PHYSICS OR CHEMICAL TECHNOLOGY, to which some appointments will date from 1st October, 1956 (or earlier in the case of selected candidates who may be available before that date). The salary will depend upon qualifications and experience, but will be within the range £600 to £900 per annum, together with F.S.S.U. benefits and family allowances. Forms of application and further particulars may be obtained from the undersigned.

Applications (two copies) should be submitted not later than 13th February, 1956.

CHARLES H. STEWART, Secretary to the University. J 695

CITY OF NOTTINGHAM.
WATER DEPARTMENT.

CIVIL ENGINEERING ASSISTANT.

Applications for this permanent pensionable appointment are invited from Engineering Graduates, and should be sent to the Engineer and General Manager, Water Department, Castle Boulevard, Nottingham, by the 11th January, 1956, with the names of two persons to whom reference may be made. Salary in accordance with Grade APT. II of the National Scale, viz., £560 by £20 to £640, or in the case of Graduates who have had at least 5 years' satisfactory experience, £650 by £25 to £775.

T. J. OWEN, Town Clerk.

Guildhall, Nottingham. J 696

ATOMIC ENERGY RESEARCH ESTABLISHMENT, HARWELL

invites applications for a post as

SENIOR ENGINEER

in the Control and Instrumentation Group of its Reactor Engineering Division, to take charge of the specification, progressing, installation and testing of control equipment and instrumentation of major research reactor projects. The work will involve the integration of development work by several divisions and commercial organisations on special items of instrumentation.

Applicants should possess corporate membership of the Institution of Electrical Engineers and should have had several years' experience in one or more of the above fields, together with a wide knowledge of standard industrial instrumentation and nucleonic techniques. An Honours Degree in Electrical Engineering or Telecommunications and Electronics would be an advantage.

Salary, according to age, qualifications and experience, within the scale:—
Engineer I, £1490–£1685 per annum.

Contributory superannuation scheme.

Send POSTCARD for application form to ESTABLISHMENT OFFICER, U.K. ATOMIC ENERGY AUTHORITY, A.E.R.E., HARWELL, DIDCOT, BERKSHIRE, quoting reference 465. J 692

STATES OF JERSEY.

SEWERAGE BOARD.

APPOINTMENT OF ASSISTANT CIVIL ENGINEER.

Applications are invited for the appointment of **ASSISTANT ENGINEER** in the office of the Consultant Engineer to the Board at a commencing salary within the range £700 to £800.

The successful applicant would be principally engaged on design of works in connection with the Island Main Drainage and Sewage Treatment Scheme for a population of 60,000. Where possible, opportunity for outside experience will be given.

Applicants should preferably be between 20 and 30 years of age, have some practical experience in sewerage or reinforced concrete work and have passed sections A and B of the Institute of Civil Engineers examination, or have some equivalent qualification.

The appointment is a temporary one, but is expected to last for at least two years. It would be terminable by one month's notice on either side. Salaries will be fixed in accordance with qualifications and experience, and an annual increment will be payable subject to satisfactory service.

Applications, stating age, whether married or single, giving full details of training, qualifications, present and previous appointments, and accompanies by copies of two recent testimonials must be delivered not later than 10th January, 1956, to the GREFFIER OF THE STATES, STATES' GREFFE, JERSEY, C.I.

The States of Jersey can undertake no responsibility for the provision of housing accommodation. J 628

CHIEF MECHANICAL AND ELECTRICAL ENGINEER
and
ASSISTANT CHIEF ELECTRICAL ENGINEER.

Vacancies exist with the Industrial Group of the UNITED KINGDOM ATOMIC ENERGY AUTHORITY for the above posts on its headquarters establishment at Risley:—

CHIEF ENGINEER—REF. NO. 1,221.

The Chief Engineer will be responsible for the organisation and management of a major department comprising the Electrical, Instrument and Mechanical Plant Design Offices working in close collaboration with a number of design groups engaged upon the industrial projects of the Authority.

The work of the department is concerned with the layout of E.H.T. systems; specification of switchgear and cabling and of large and small rotating machines; H.T. and L.T. factory distribution; control and instrumentation of nuclear reactors and process plants; design and selection of instruments for measuring temperature pressure, flow pH and radioactivity and analysing gases and liquids; ancillary boiler plant and steam distribution; compressed air, water and gas services; lifting appliances; workshop equipment and heating and ventilation.

Candidates must be Corporate Members of the Institution of Civil, Mechanical or Electrical Engineers and have had wide appropriate experience in a responsible position.

SALARY: £2700-£3200.

ASSISTANT CHIEF ENGINEER—REF. NO. 1,222.

The Assistant Chief Engineer will be in charge of a section of the Electrical Design Office responsible for the detailed design of E.H.T. and H.T. networks, substations and protective gear and H.T. and L.T. factory distribution as a service to the main design groups engaged upon the industrial projects of the Authority, such as Nuclear Reactors and chemical and physical processing plants. The electrical installations include both generation and utilisation. He will also be responsible for arranging for the execution of the work by contract and will be required to conduct technical negotiations with supply authorities.

Candidates must be Corporate Members of the Institution of Electrical Engineers and have had considerable appropriate experience. Experience in the design of motors and transformers will be an advantage.

SALARY: £1700-£2200.

Successful candidates under 55 will be required to join the Authority's contributory pension scheme, which includes widows' and dependants' benefits.

Suitably qualified persons are invited to write quoting the appropriate reference number to the SENIOR RECRUITMENT OFFICER, U.K.A.E.A., INDUSTRIAL GROUP HEADQUARTERS, RISLEY, near WARRINGTON, LANCASHIRE.

Closing date 13th January, 1956. J 722

CENTRAL ELECTRICITY AUTHORITY require **THIRD ASSISTANT ENGINEER** at Headquarters in London to assist an engineer responsible or co-ordinating construction work at a number of power stations. Knowledge of modern power station work is essential and practical experience of site work would be an advantage. Candidates should have qualifications equivalent to Graduate of the Institution of Electrical Engineers or Institution of Mechanical Engineers standard. Salary within N.J.B. Grade 3, £908-£1125 p.a. inclusive.—Applications stating age, qualifications, experience, present position and salary to D. MOFFAT, DIRECTOR OF ESTABLISHMENTS, WINSLEY STREET, LONDON, W.1, by 14th January, 1956. Quote Ref. AE/720. J 691

KENT COUNTY COUNCIL.

SENIOR HEATING ENGINEERS required with good experience in the design of installations for all types of buildings. Salary within scales £825 to £1000 and £675 to £825, according to ability and experience. Applicants must be Corporate Members of the Institution of Heating and Ventilating Engineers. Application forms from COUNTY ARCHITECT, SPRINGFIELD, MAIDSTONE. Closing date 12th January, 1956. J 677

EAST MIDLANDS GAS BOARD.

LEICESTER AND NORTHANTS DIVISION.

APPOINTMENT OF MAINS SUPERINTENDENT.

Applications are invited for the post of Mains Superintendent for the Leicestershire and Rutland Group of Undertakings. The appointment will be made in Grades APT. 11/12 (salary range £785 to £960) and the salary at commencement will be dependent upon the experience of the person appointed.

Wide practical experience of civil engineering work, specialising in mainlaying, and proven ability in leadership are essential.

The Mains Superintendent, who will be required to reside in or near Leicester, will have direct operational responsibility, under the Divisional Distribution Engineer, for all practical gas distribution work in the Leicestershire/Rutland area; including the carrying out of all main/service laying and maintenance work, whether by direct or contract labour; the control, training and deployment of Distribution personnel, and the quality and output of their work; supervision of Distribution transport, stores and tackle; and liaison with local authority and other services. He will have a staff adequate for this purpose.

The post is pensionable and the successful applicant will be required to pass a medical examination. Pension Interchange arrangements are in operation between the Board and Local Government, Civil Service, and certain other Public Bodies.

Applications, stating age and giving full details of experience and qualifications, if any, together with the names of three referees, should be addressed to reach the undersigned not later than 7th JANUARY, 1956.

H. B. TAYLOR,
Divisional General Manager.

Gas Offices,
Millstone Lane,
Leicester. J 657

CARMARTHENSHIRE EDUCATION COMMITTEE.

AMMANFORD TECHNICAL COLLEGE.

Applications are invited for the post of full-time **ASSISTANT IN THE MINING AND ENGINEERING DEPARTMENT** of the above named College.

Candidates must be Graduate in Mining or Engineering or possess qualifications of an equivalent standard. Industrial and teaching experience will be an advantage.

Salary in accordance with the Burnham Technical Report, 1954, for Grade A Assistants including allowances for approved teaching and industrial experience.

Duties to commence as soon as possible.

Forms of application, which must be returned within TWO WEEKS of the appearance of this advertisement, may be obtained from the undersigned on receipt of a stamped addressed envelope.

IORWERTH HOWELLS,
Director of Education.

Education Offices,
County Hall,
Carmarthen. J 726

ATOMIC ENERGY RESEARCH ESTABLISHMENT, HARWELL
invites applications for posts in its
ENGINEERING SERVICES DIVISION

(i) Ref. 468. **TO LEAD A SMALL TEAM IN THE PLANNING AND PROGRESSING OF A WIDE VARIETY OF RESEARCH AND EXPERIMENTAL EQUIPMENT** being produced by the Workshops Group.

(ii) Ref. 467. **TO ASSIST IN PLANNING AND PROGRESSING THE MANUFACTURE OF A LARGE VARIETY OF EQUIPMENT,** which is carried out in the Workshops of the Design and Manufacture Group at Harwell.

Applicants should have served a recognised engineering apprenticeship. Possession of an Ordinary National Certificate, or an equivalent qualification, would be an advantage.

For (i) applicants should have several years' Workshop experience, with a wide knowledge of modern workshop techniques and practice covering machining, fitting and fabrication.

For (ii) applicants should be thoroughly conversant with modern Workshop practice, and previous experience of job progressing in a large workshop is desirable.

SALARY, according to age, qualifications and experience, within the scales:—
(i) Technical Class, Grade II, £743 (at age 30)-£873 per annum.
(ii) Technical Class, Grade III, £608 (at age 26)-£748 per annum.

Contributory superannuation scheme.

Send POST CARD for application form to ESTABLISHMENT OFFICER, U.K. ATOMIC ENERGY AUTHORITY, A.E.R.E., HARWELL, DIDCOT, BERKS., quoting appropriate reference. J 728

ADMIRALTY.
ROYAL NAVAL SCIENTIFIC SERVICE.

ENGINEERS AND PHYSICISTS (PARTICULARLY WITH ELECTRONICS) required in Experimental Officer and Assistant Experimental Officer grades in Experimental Establishments in London, Portsmouth, Weymouth areas, Gloucestershire and Scotland. Qualifications: British subjects, minimum of H.S.C. (Pass degree, H.N.C. or near equivalent an advantage). London salary (men), E.O. £790-£960, A.E.O. £320 10s.-£700 (according to age). Appointments unestablished but opportunities to compete for established posts.—Application forms from M.L.N.S., TECHNICAL AND SCIENTIFIC REGISTER (K), 26, KING STREET, LONDON, S.W.1, quoting A214/5A. J 724

CENTRAL ELECTRICITY AUTHORITY require the following in the Station Design and Layout Sub-Branch at Headquarters in London for work consisting largely of investigating and co-ordinating proposals for the general design and layout of power stations:—

SECOND ASSISTANT ENGINEER. Candidates should possess an honours degree in engineering and/or be corporate members of either the Institution of Mechanical Engineers or the Institution of Electrical Engineers, and should have wide experience in the design and layout of large modern power stations. Salary within Grade 2 N.J.B., £971-£1325 p.a. inclusive.

THIRD ASSISTANT ENGINEER. Candidates should preferably possess a degree in engineering and/or the requisite examination qualification for corporate membership of the Institution of Mechanical Engineers or the Institution of Electrical Engineers, and should have some practical experience of power station work. Salary within Grade 3 N.J.B., £908-£1125 p.a. inclusive.

Applications stating age, qualifications, experience, present position and salary to D. MOFFAT, DIRECTOR OF ESTABLISHMENTS, WINSLEY STREET, LONDON, W.1, by 14th January, 1956. Quote Ref. AE/723 and specify which vacancy applied for. J 721

DESIGN ENGINEER required in N.C.B's Headquarters Production Engineering Branch, located at Stanhope Bretby, near Burton-on-Trent, for technical investigations into design of mining machinery and equipment, and use of new materials. Wide experience of this type of work and an Engineering Degree or equivalent required, preferably with Corporate Membership of Institute of Mechanical Engineers.

Appointment (superannuable) within range £1122-£1650.

Write, with full particulars of age, education, qualifications and experience to NATIONAL COAL BOARD, STAFF DEPT. (PERSONNEL), HOBART HOUSE, GROSVENOR PLACE, LONDON, S.W.1, MARKING ENVELOPE SS/145, by 16th January, 1956. J 715

CENTRAL ELECTRICITY AUTHORITY require a **SECOND ASSISTANT ENGINEER** in Plant Design Sub-Branch at Headquarters in London, to assist in investigating the economics of plant development associated with turbines, feed heating, condensing plant and auxiliary equipment. Candidates should possess a good general knowledge of such plant, and have had some experience in the preparation and presentation of economic studies. Preferably they should have an engineering degree or be Corporate Members of the Institution of Mechanical Engineers. Salary within N.J.B. Grade 2, £971-£1325 p.a. inclusive.

Application forms from D. MOFFAT, DIRECTOR OF ESTABLISHMENTS, WINSLEY STREET, LONDON, W.1, to be completed and returned not later than 15th January, 1956. Quote Ref. AE/721. J 712

PORT OF LONDON AUTHORITY.

The Port of London Authority invite applications for the position of

LEADING TECHNICAL ASSISTANT (ELECTRICAL) in the Drawing Office of the Authority. The scale of pay is £600 per annum rising subject to certain conditions by annual increments of £25 to £725 per annum, with the commencing rate according to qualifications and experience.

Applicants, who must be British subjects and have obtained the Ordinary National Certificate in Electrical Engineering, should have had experience in the layout of distribution networks and substations, building wiring and lighting schemes, and also motor and control gear schematic and wiring diagrams.

The successful applicant will be required to join the Authority's contributory superannuation scheme. In certain cases existing pensionable service is transferable.

Application forms may be obtained from the ESTABLISHMENT OFFICER, PORT OF LONDON AUTHORITY, TRINITY SQUARE, LONDON, E.C.3. J 725

APPOINTMENTS OPEN.

THE ENGAGEMENT OF PERSONS answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18-64 inclusive or a woman aged 18-59 inclusive unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order 1952.

It is advisable when sending testimonials to forward copies and NOT originals.

STEEL BUYING AGENTS with wide effective connections in this country, should contact well-known and expanding organisation.—BOX J 441, Offices of ENGINEERING.

TECHNICAL ASSISTANT of H.N.C. standard or equivalent required for work on high speed diesel engine development. Salary commensurate with qualifications demanded. Pension scheme.—Apply to CHIEF PERSONNEL OFFICER, PETTERS LIMITED, CAUSEWAY WORKS, STAINES. G 615

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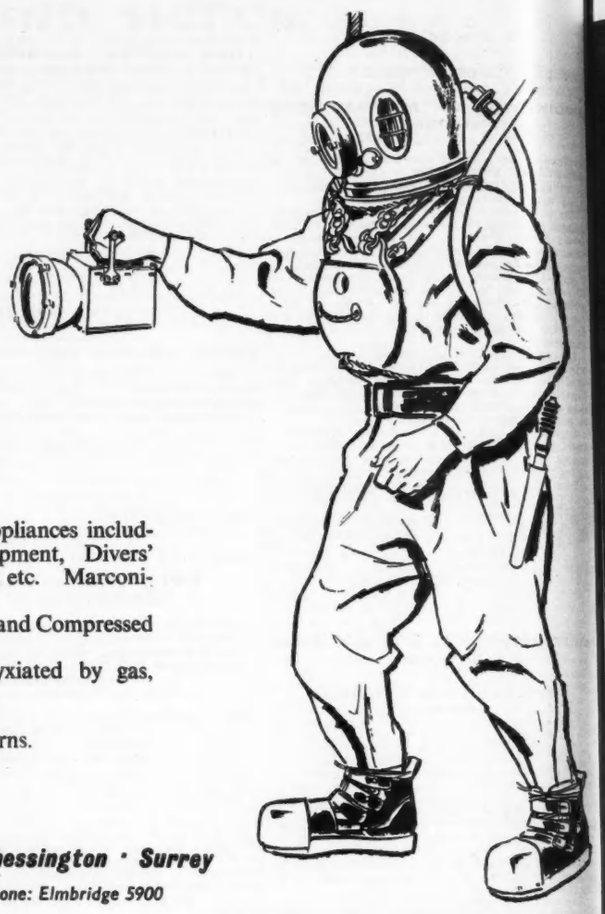

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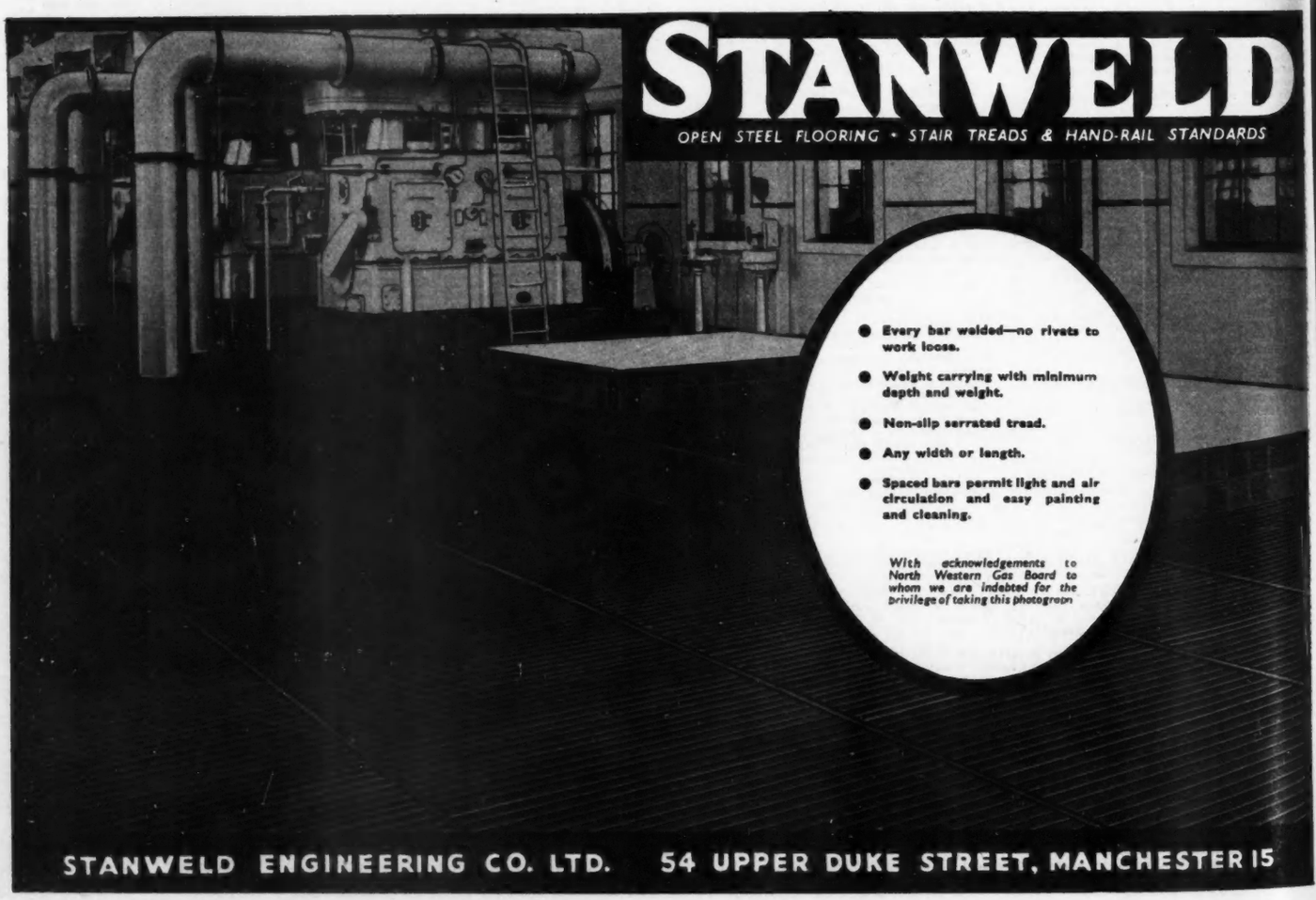
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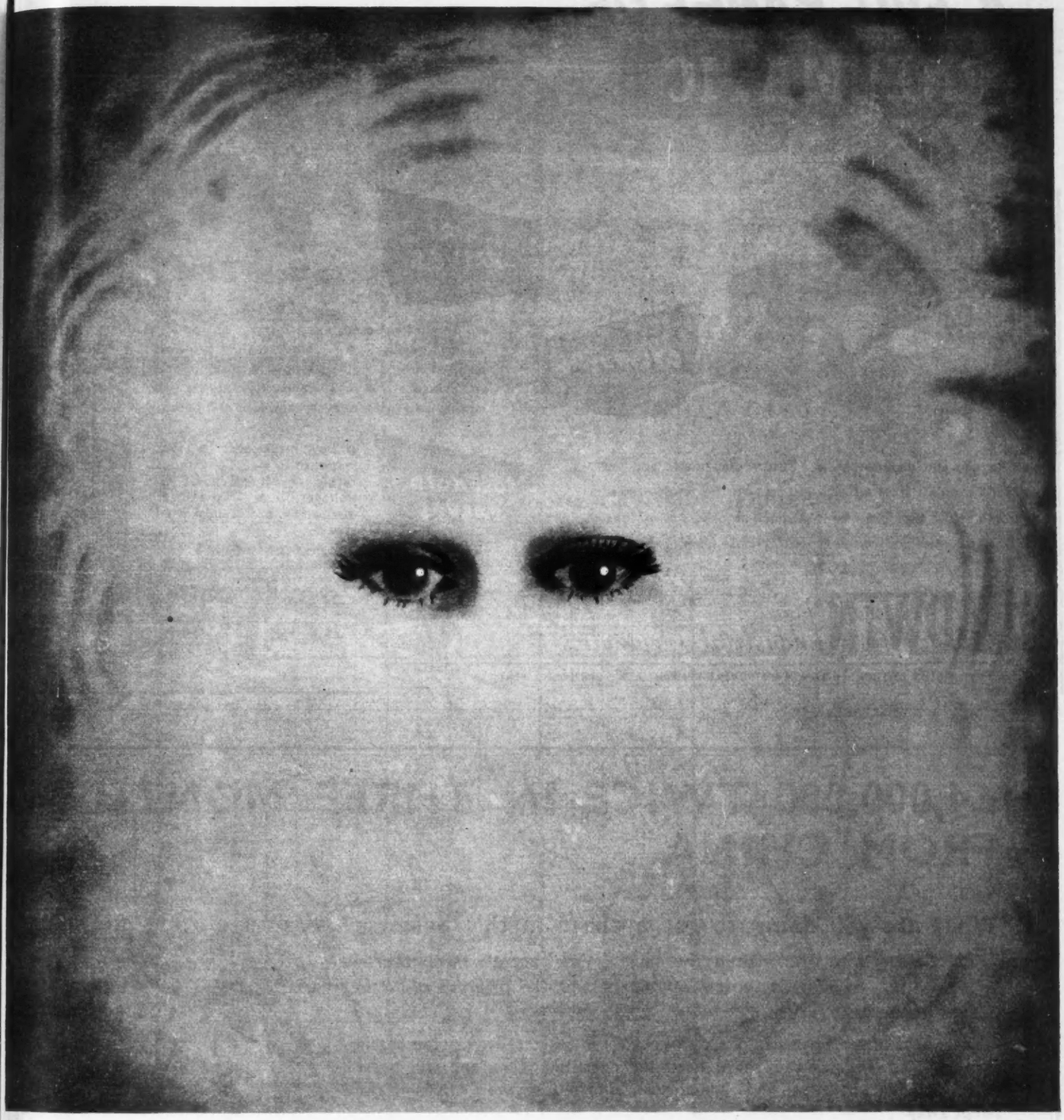

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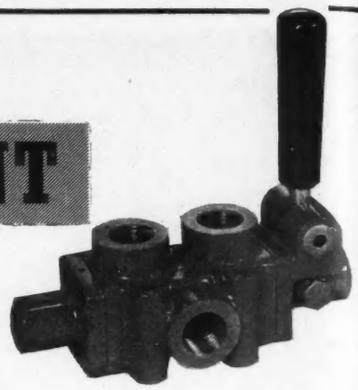

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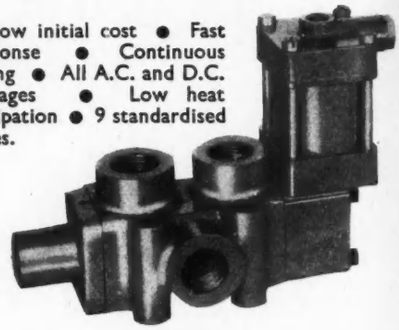

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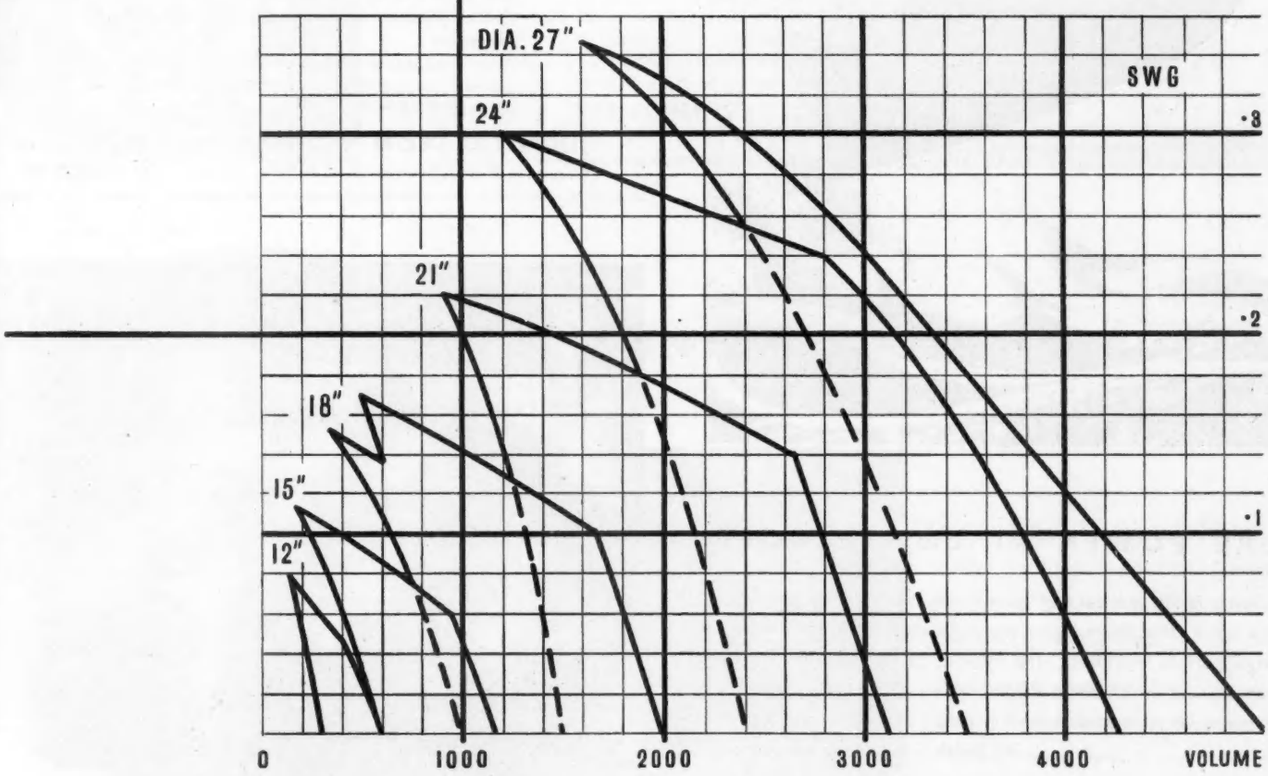

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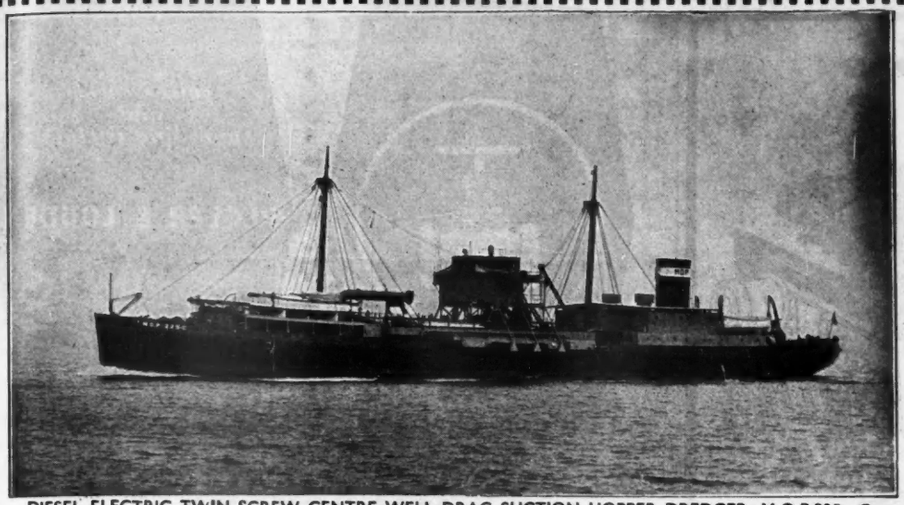

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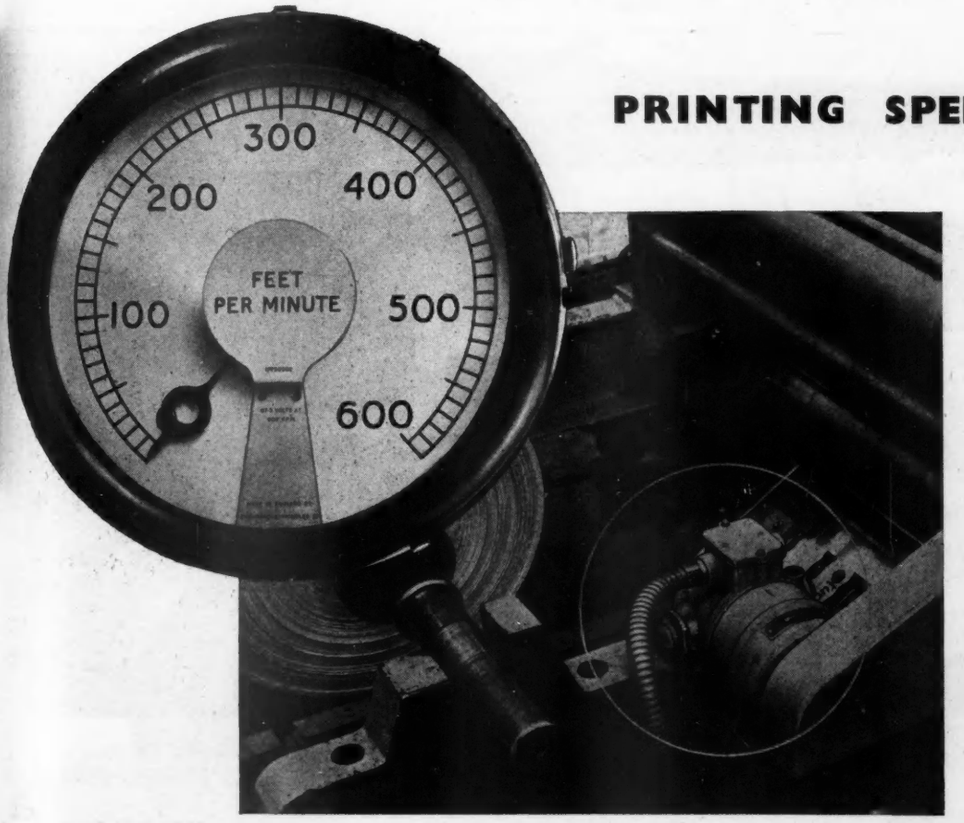

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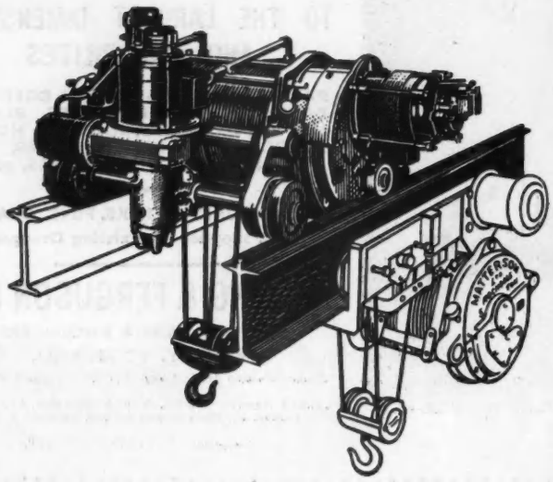

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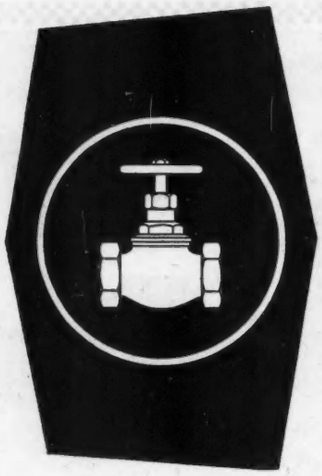

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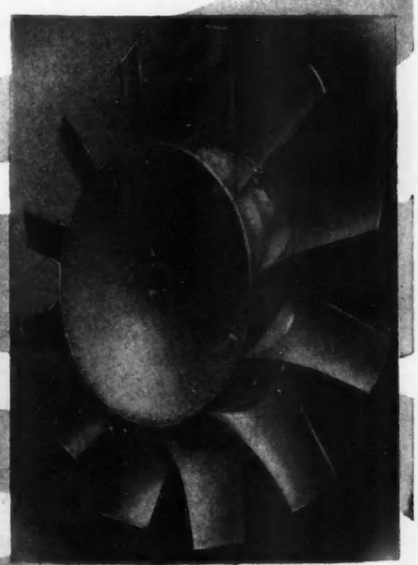

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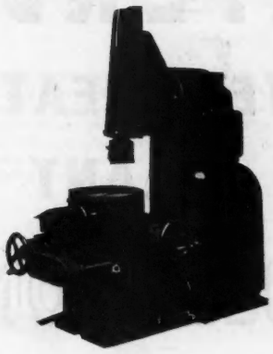
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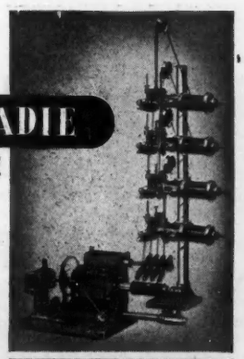
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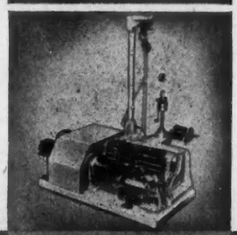
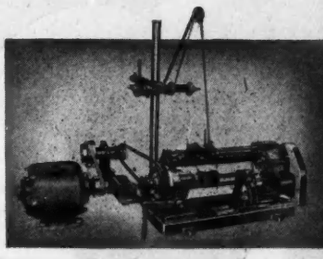
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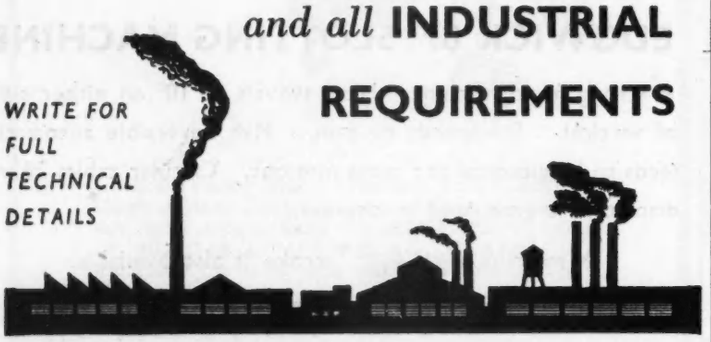

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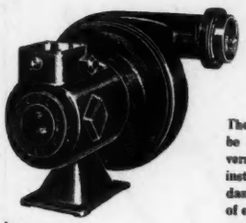

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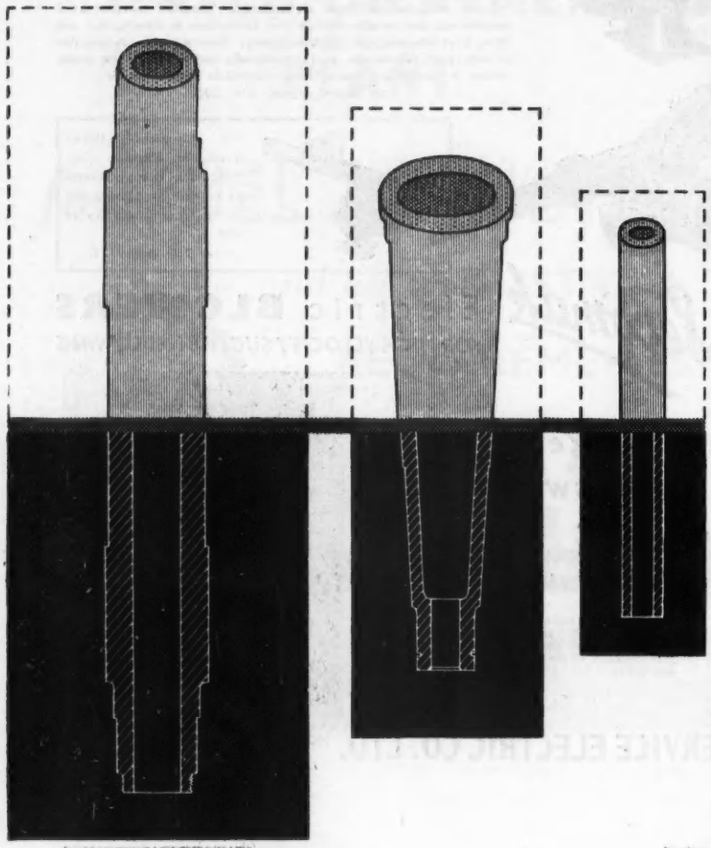

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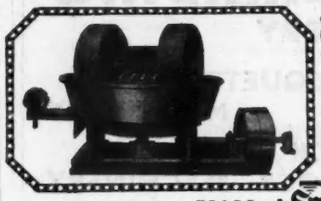

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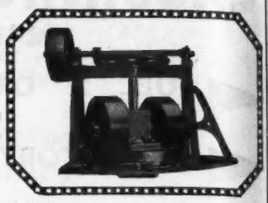

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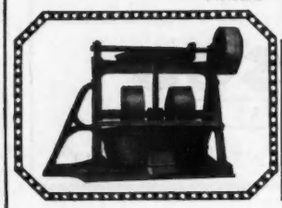

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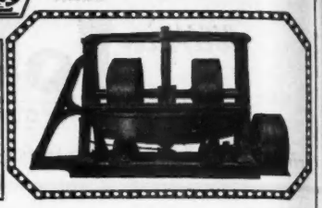

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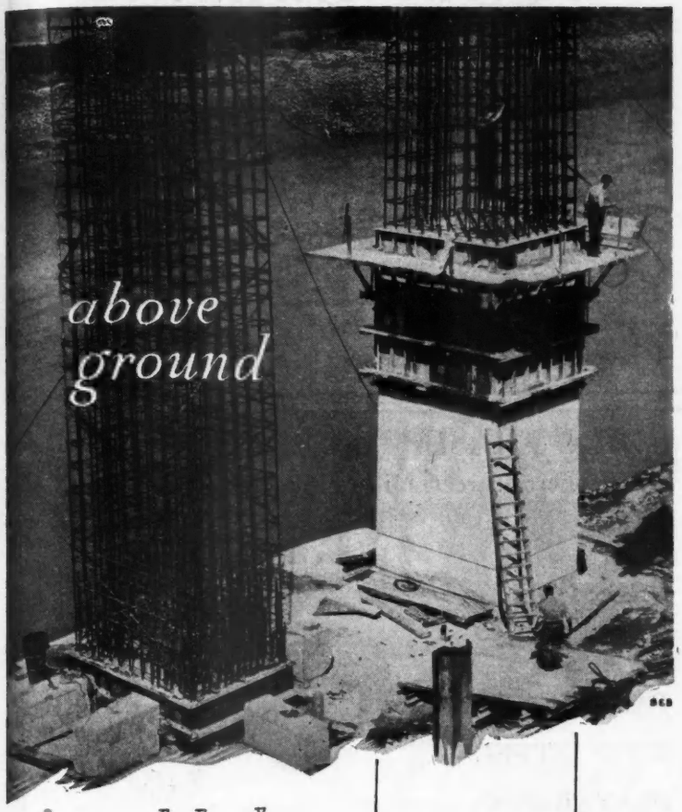

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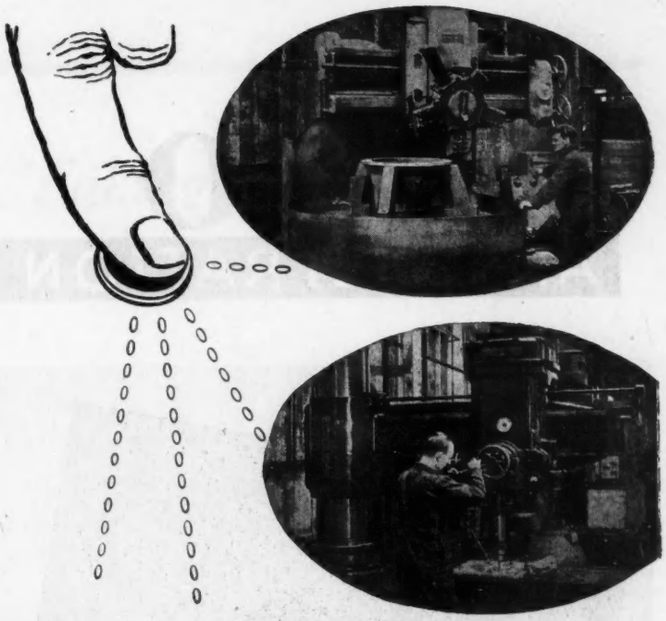

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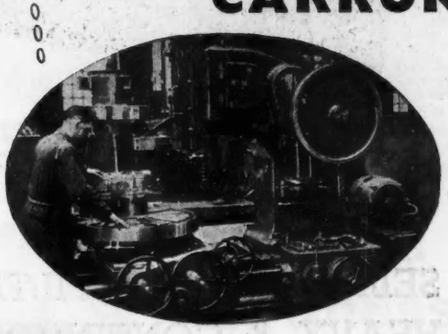

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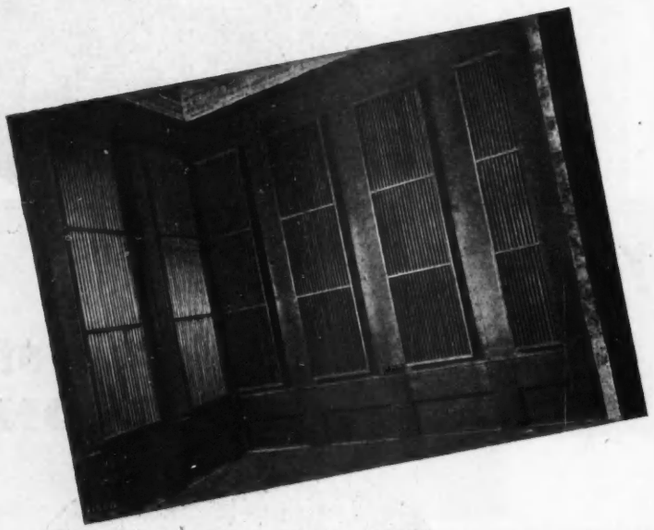

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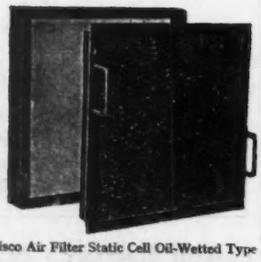

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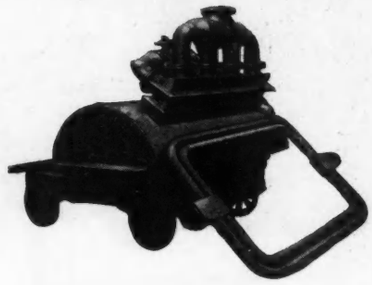

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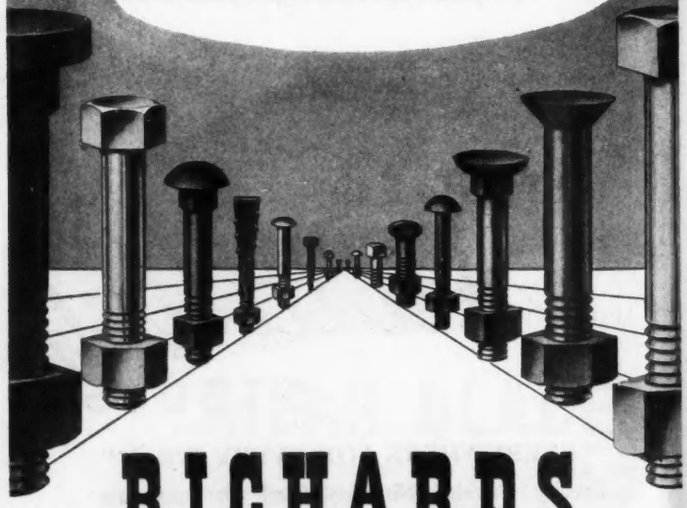

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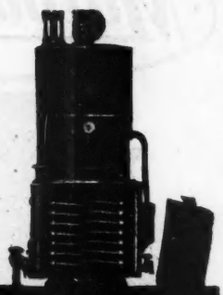

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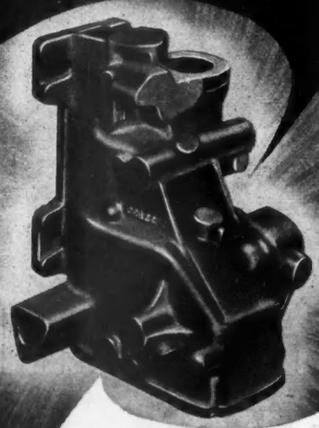

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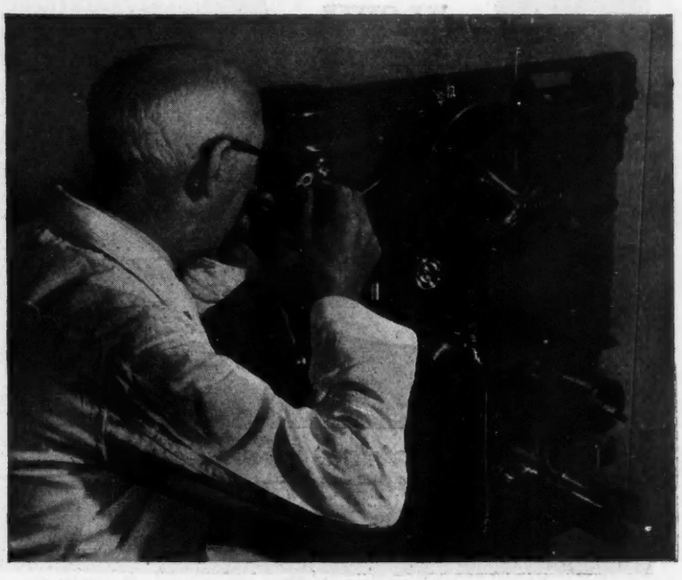

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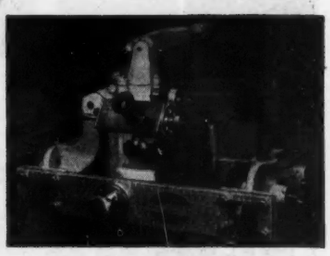

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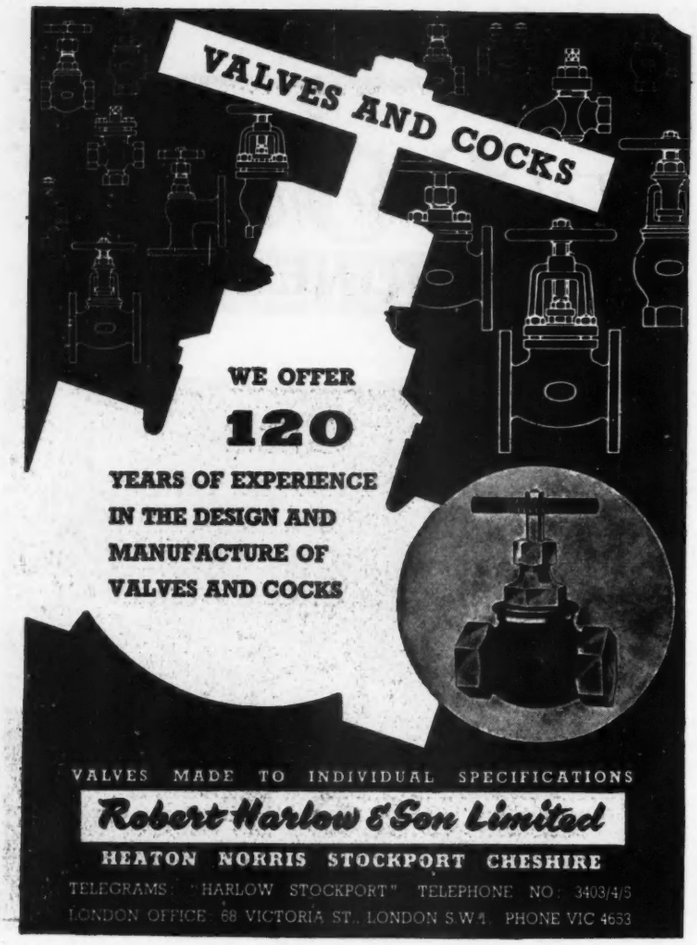
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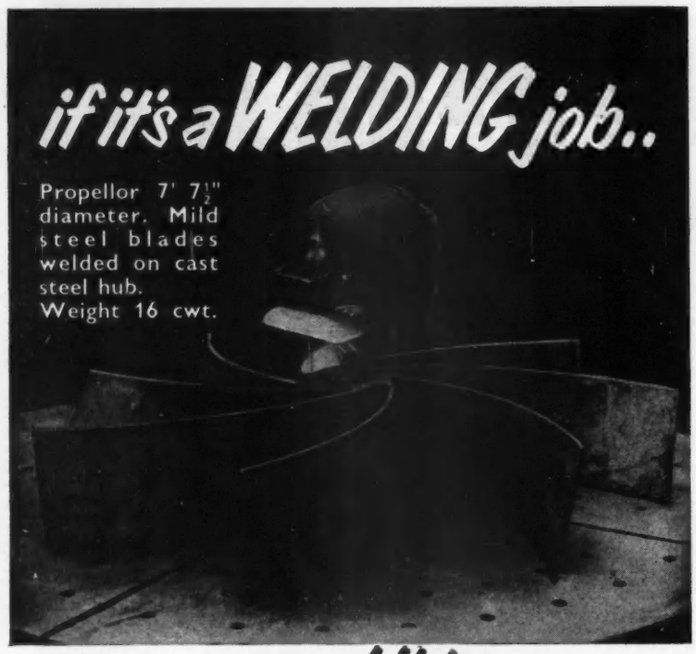

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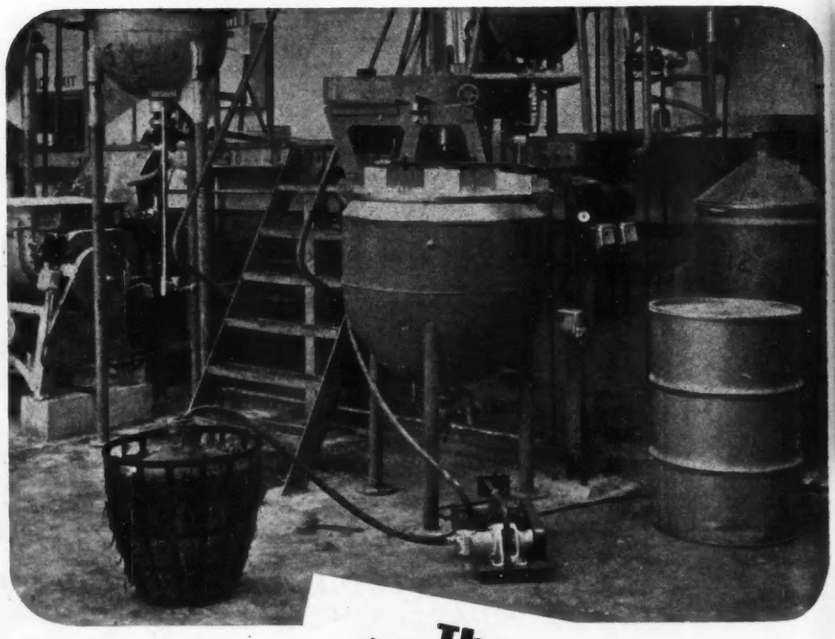

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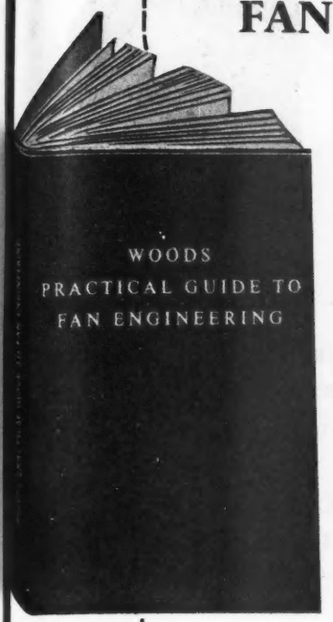

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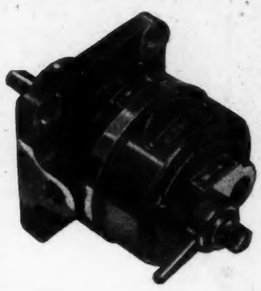

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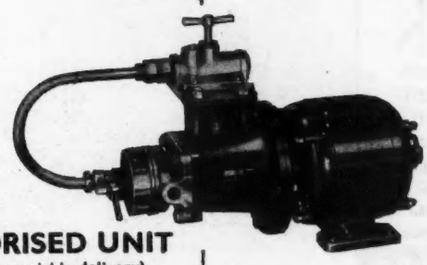

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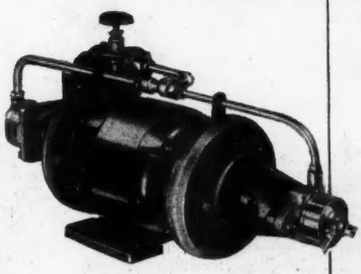

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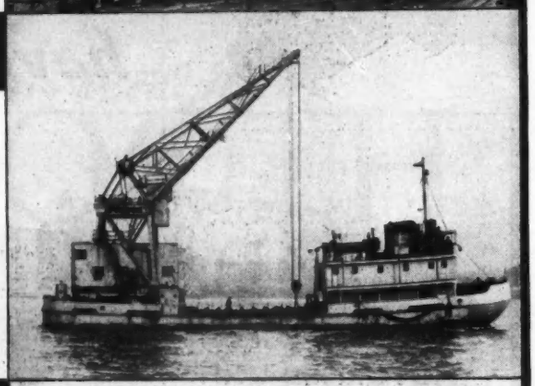

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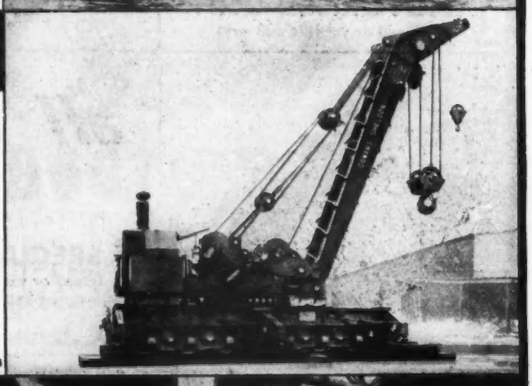
The Western Australian Government Railways



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"What advantages has Ferobestos over other materials?"

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- High dimensional stability

"How is Ferobestos supplied?"

Ferobestos plastics are usually supplied in sheets, rods and tubes, but they can also be moulded to your requirements where contour permits and where quantity justifies the cost of mould tools. All forms of machining are carried out for you where necessary.

"How are other engineers using Ferobestos?"

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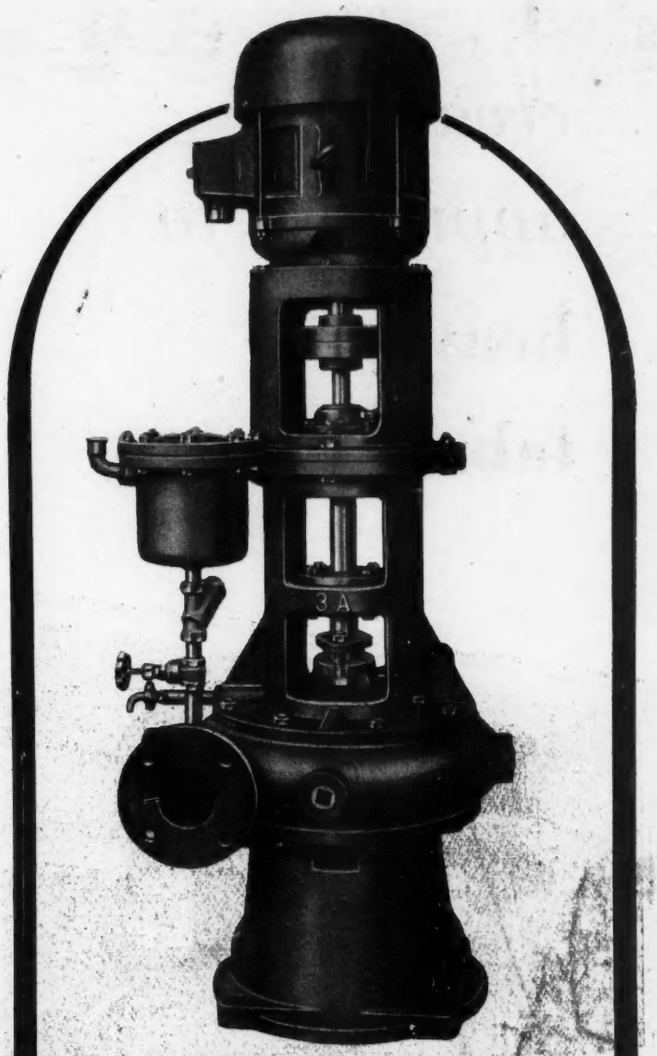

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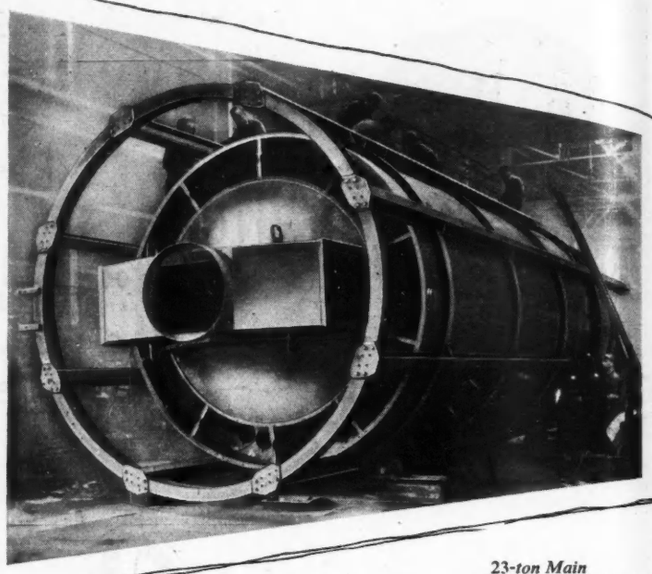

23-ton Main Body, Oil Distillation Unit

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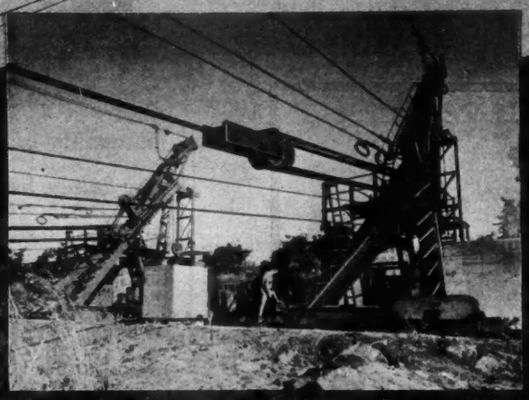

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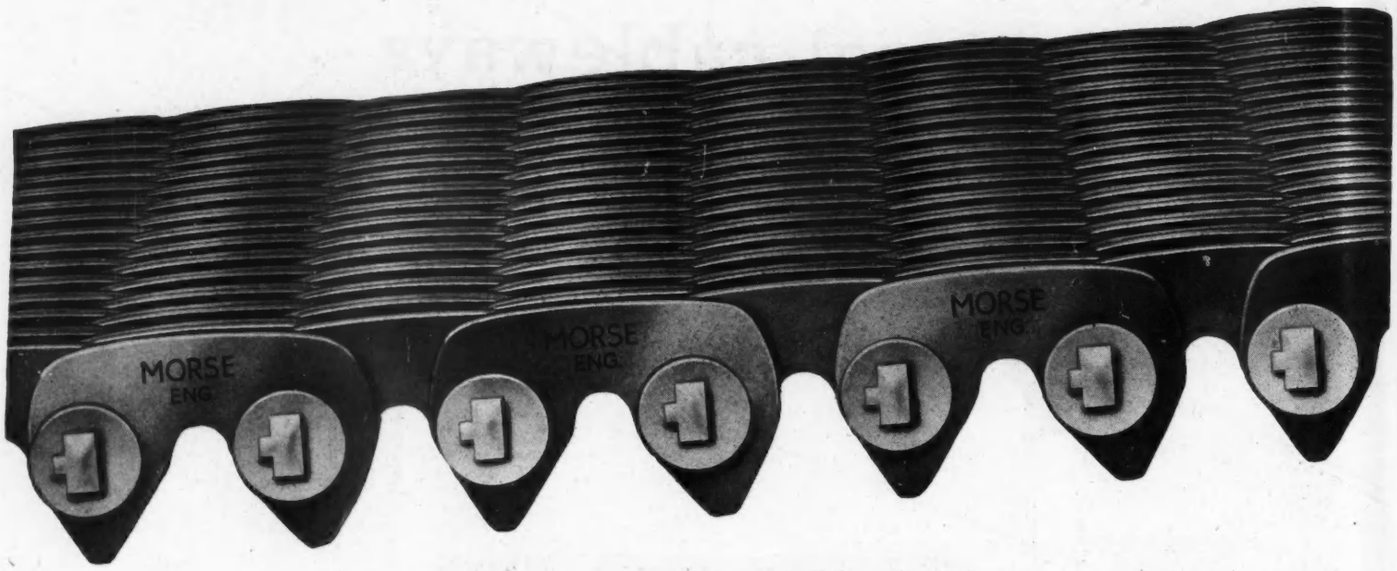
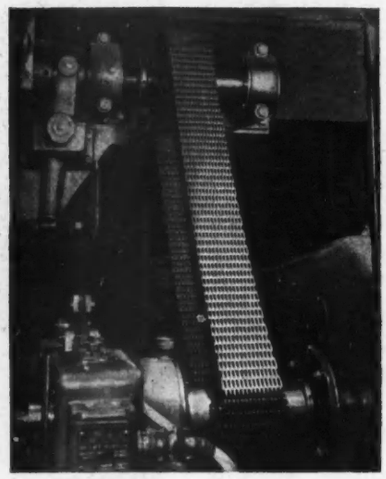


The illustration is of one of twelve 70 h.p. Morse Inverted Tooth Chain Drives installed over 19 years ago at the Radio Times Works of Waterlow & Sons, Ltd., to drive the printing presses producing the Radio Times. They have been in constant operation since the day of installation. Chain size: 1 in. pitch by 6 in. wide.



Picture by courtesy of Waterlow & Sons, Ltd.

For centuries the hallmark has been the symbol of the integrity and the pride of the craftsman in the quality of his work and an assurance to the user that he has a product upon which he can rely. In the same way, the word " Morse " stamped on each link of every Morse Chain symbolises and guarantees the quality of material, the precision manufacture and the long experience which have made Morse the leader in the field of chain engineering.

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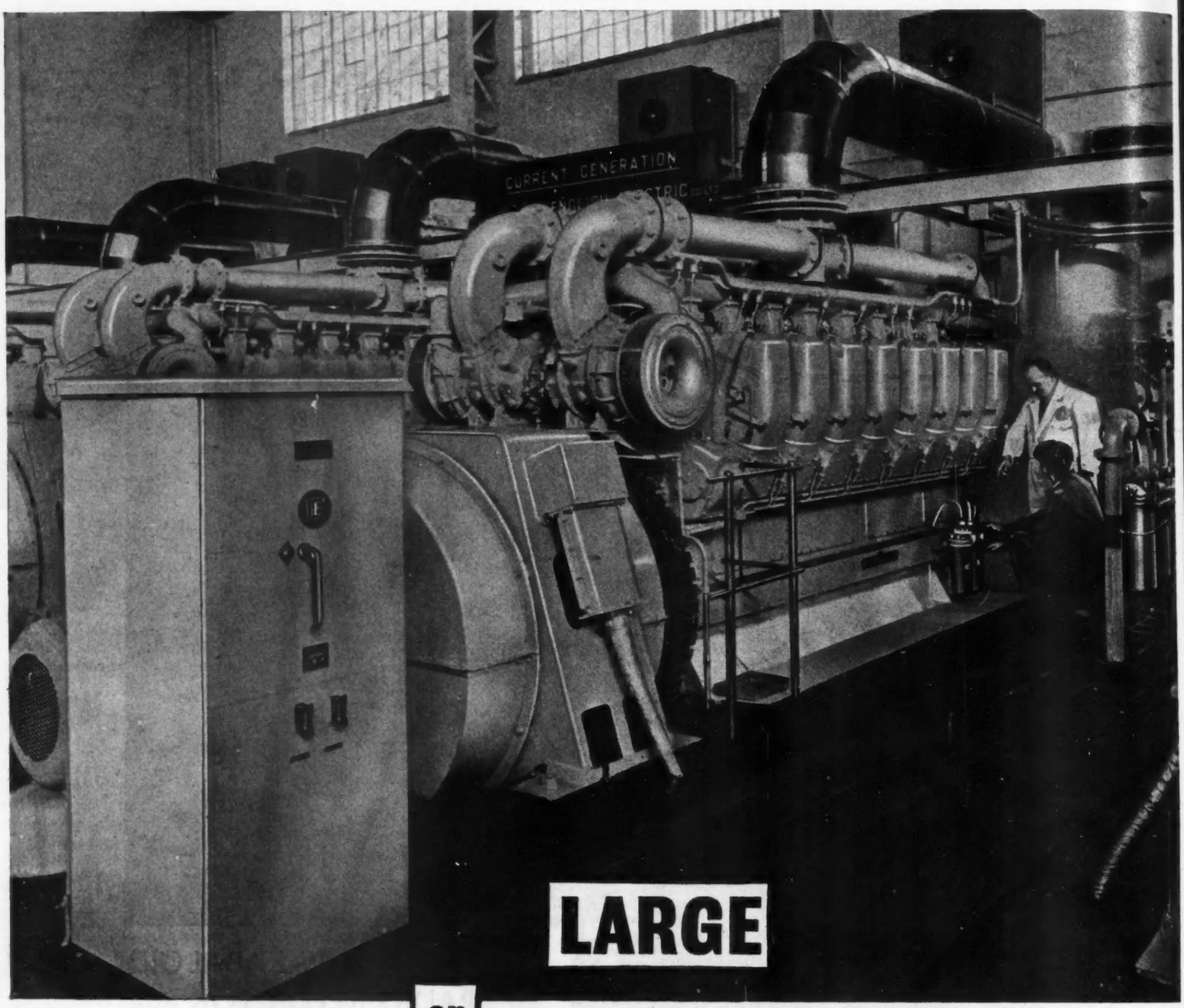
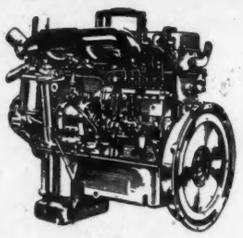


LARGE

or

small



Perkins P6 Engine

Three 1,000 kW. 'English Electric' type 16SV diesel-alternator sets. Photo by courtesy of Leyland Motors Limited.

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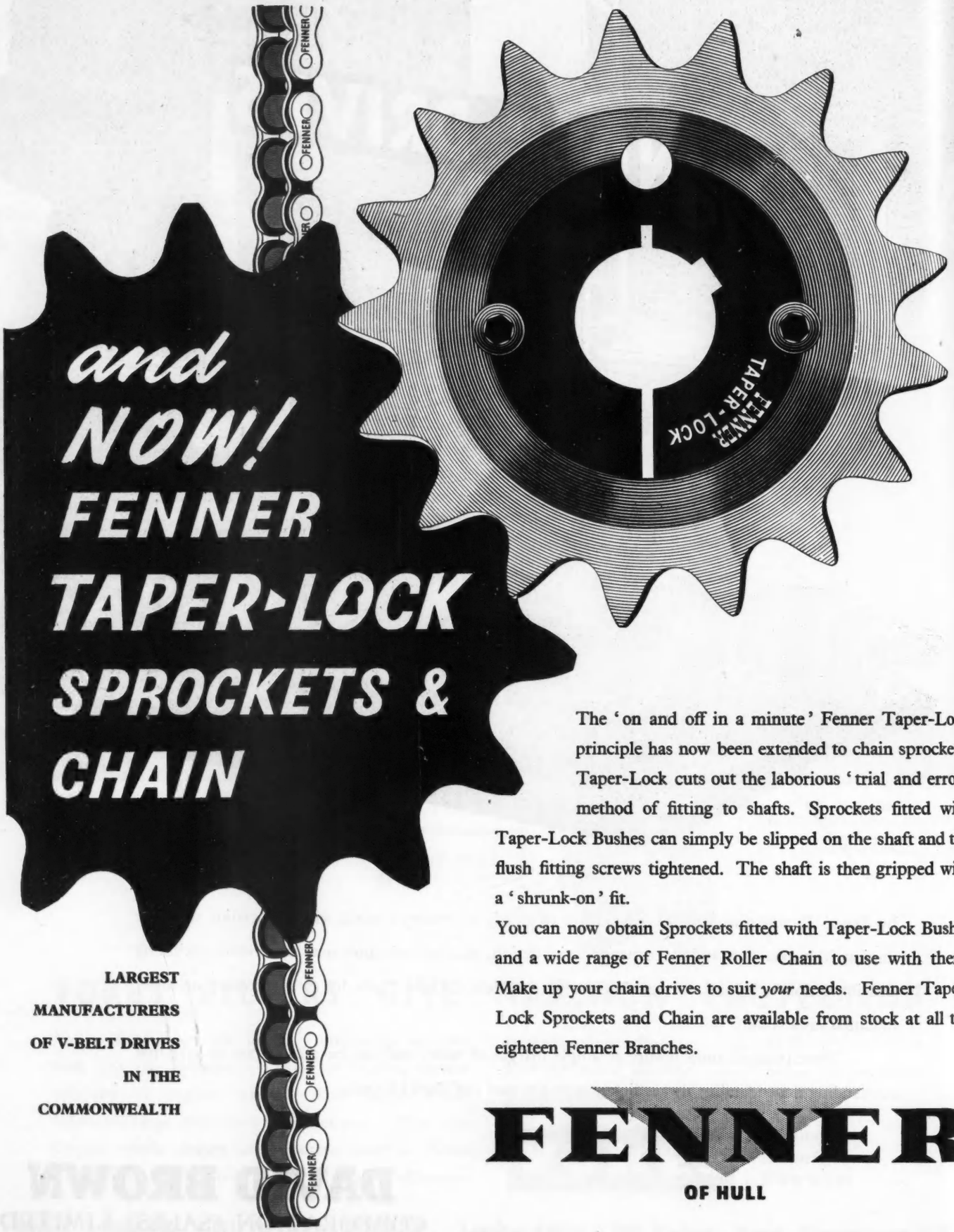

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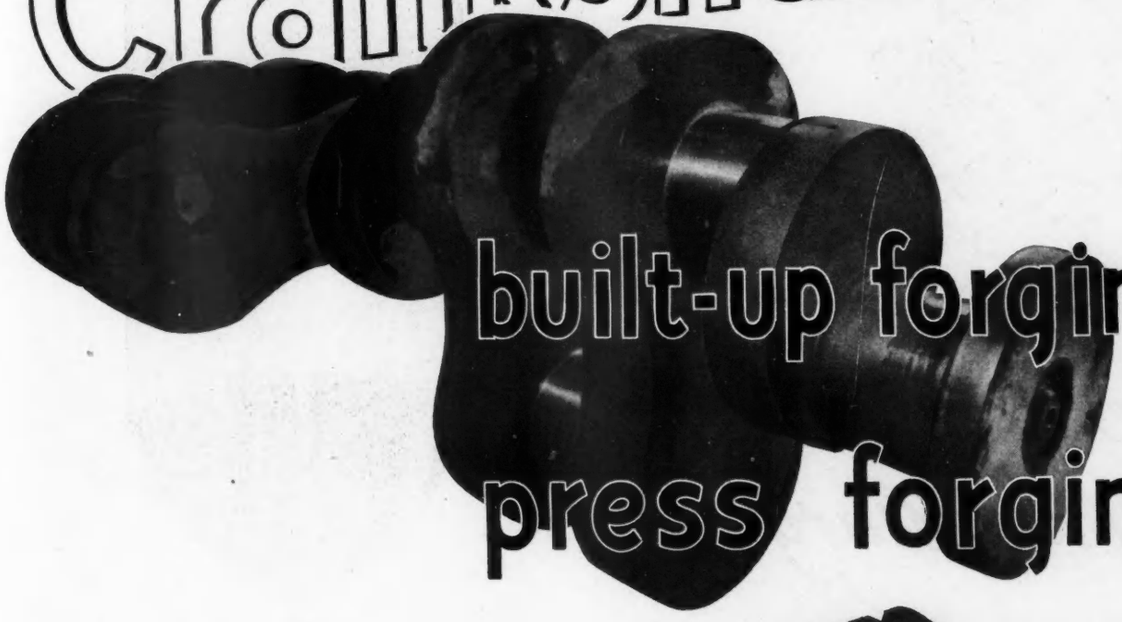

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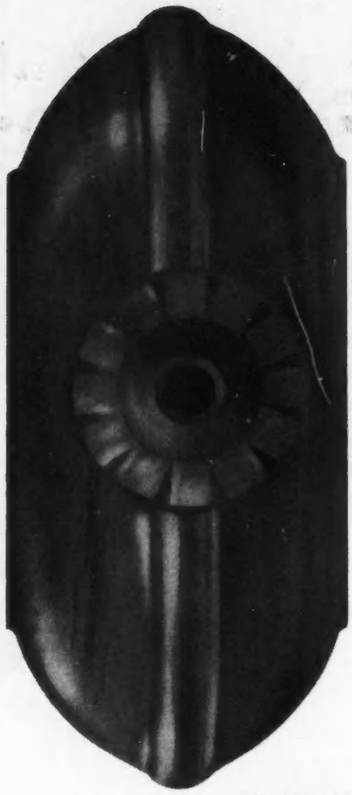

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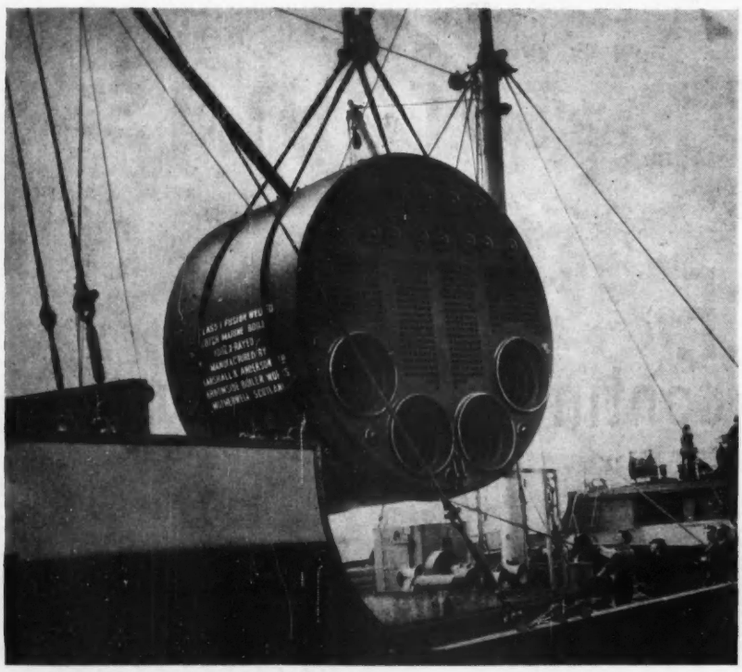

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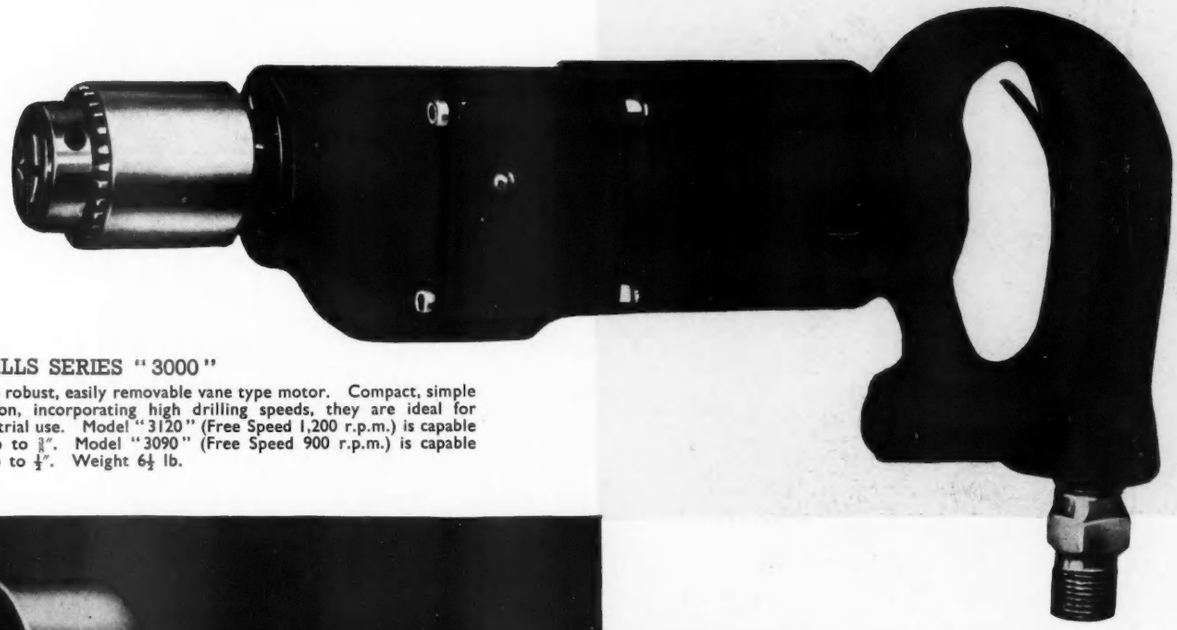

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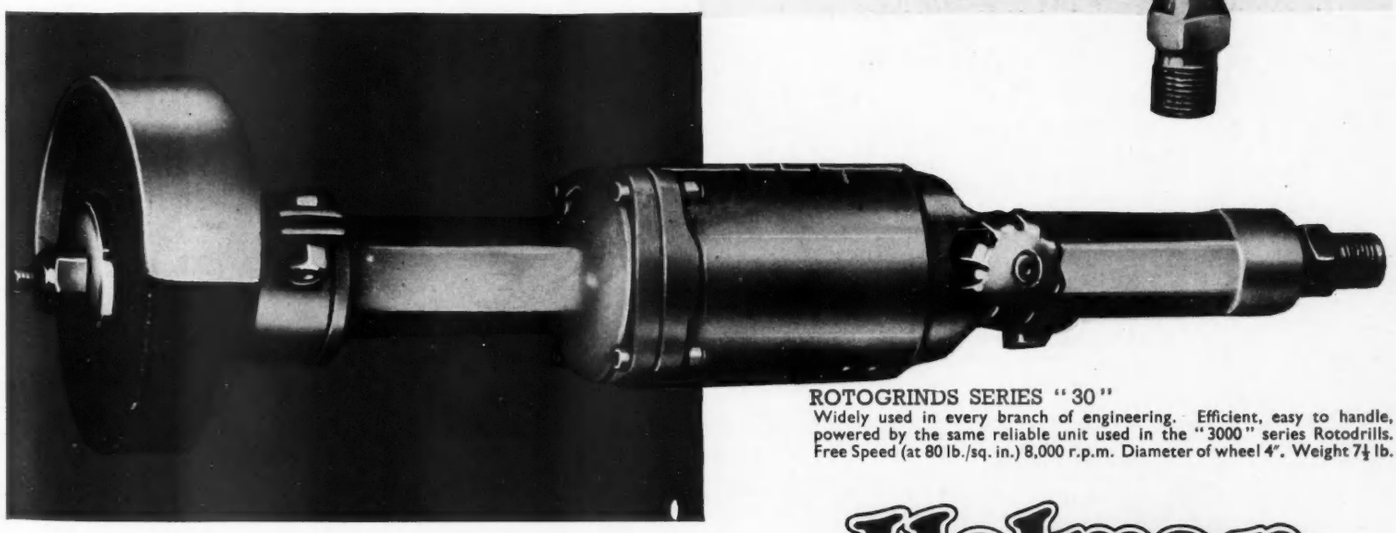

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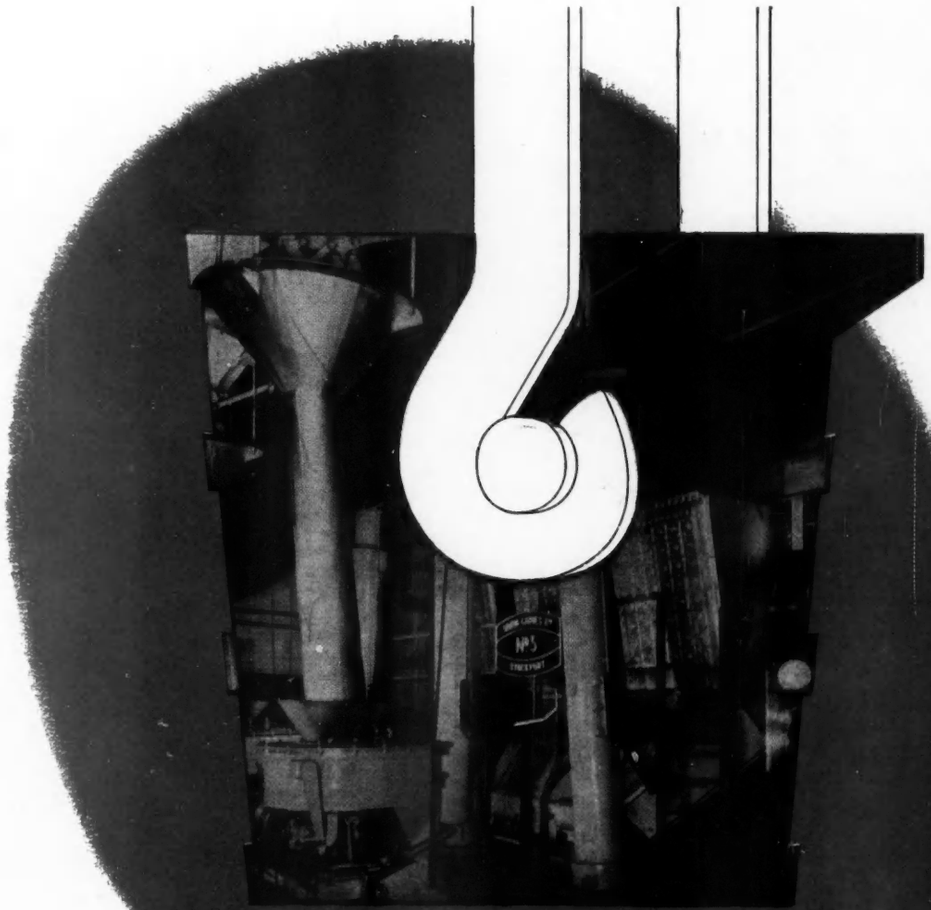

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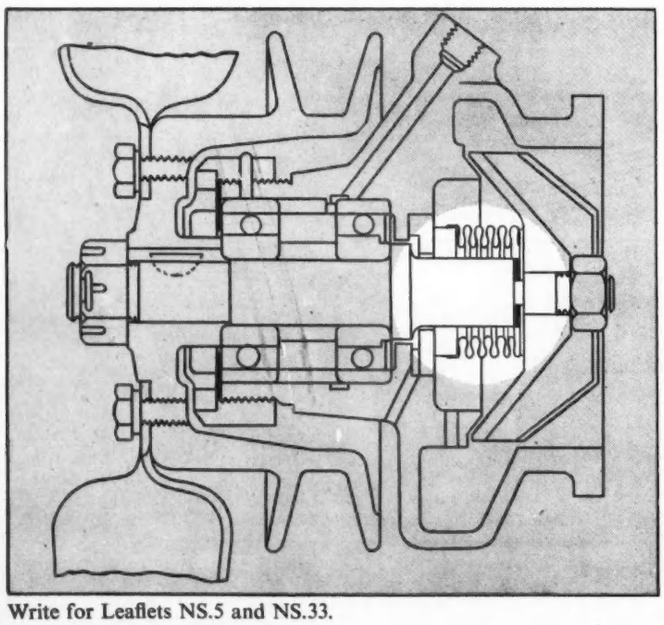

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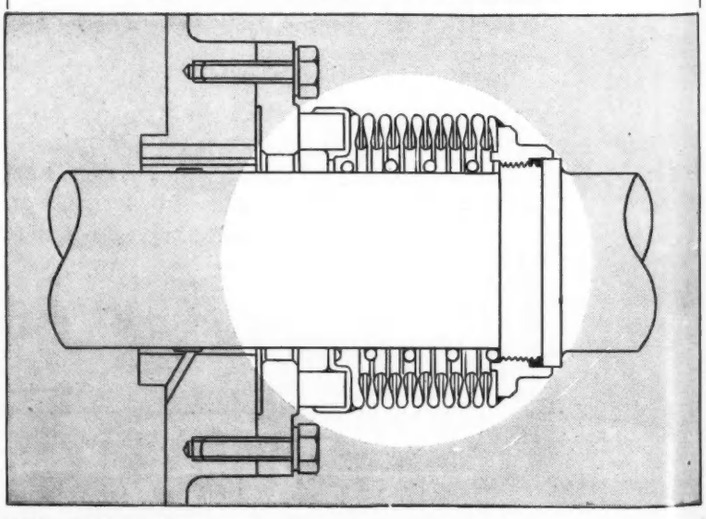

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Architects: *Brownrigg & Turner* B.A., A/ARIBA
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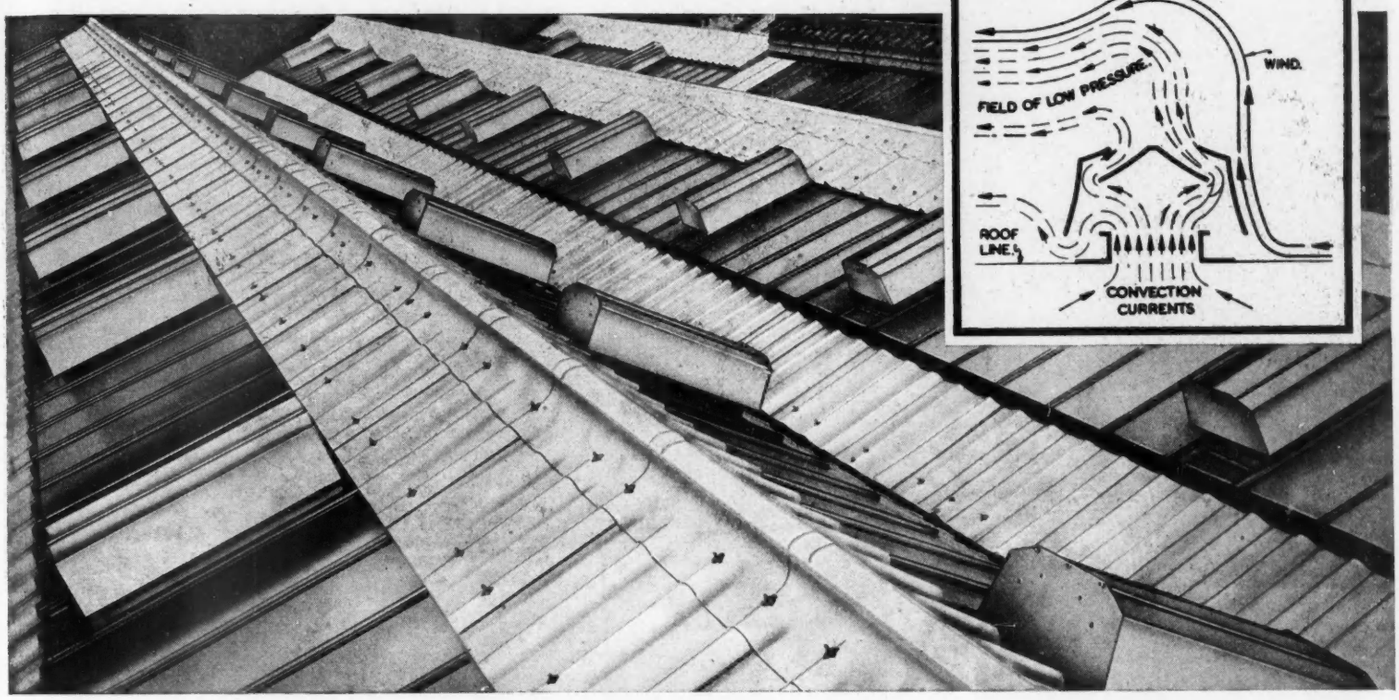

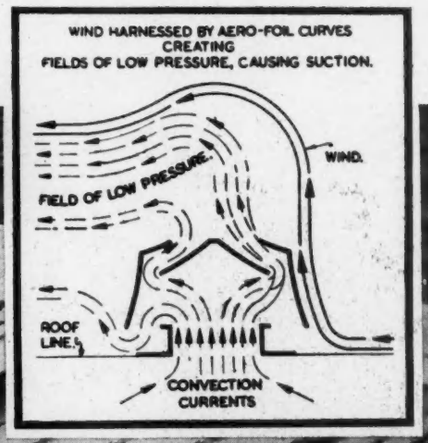
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WIND.
FIELD OF LOW PRESSURE
ROOF LINES
CONVECTION CURRENTS

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At this stage Colt were consulted and a natural ventilation scheme was designed to ensure a temperature rise of not more than 10°F at working level during the warmest summer weather. This was achieved by installing 50 Colt SRC.2046 controllable High Duty Roof Extractor Ventilators. The photograph shows the inconspicuous nature of the ventilators which are easily fixed into the glazing bars.

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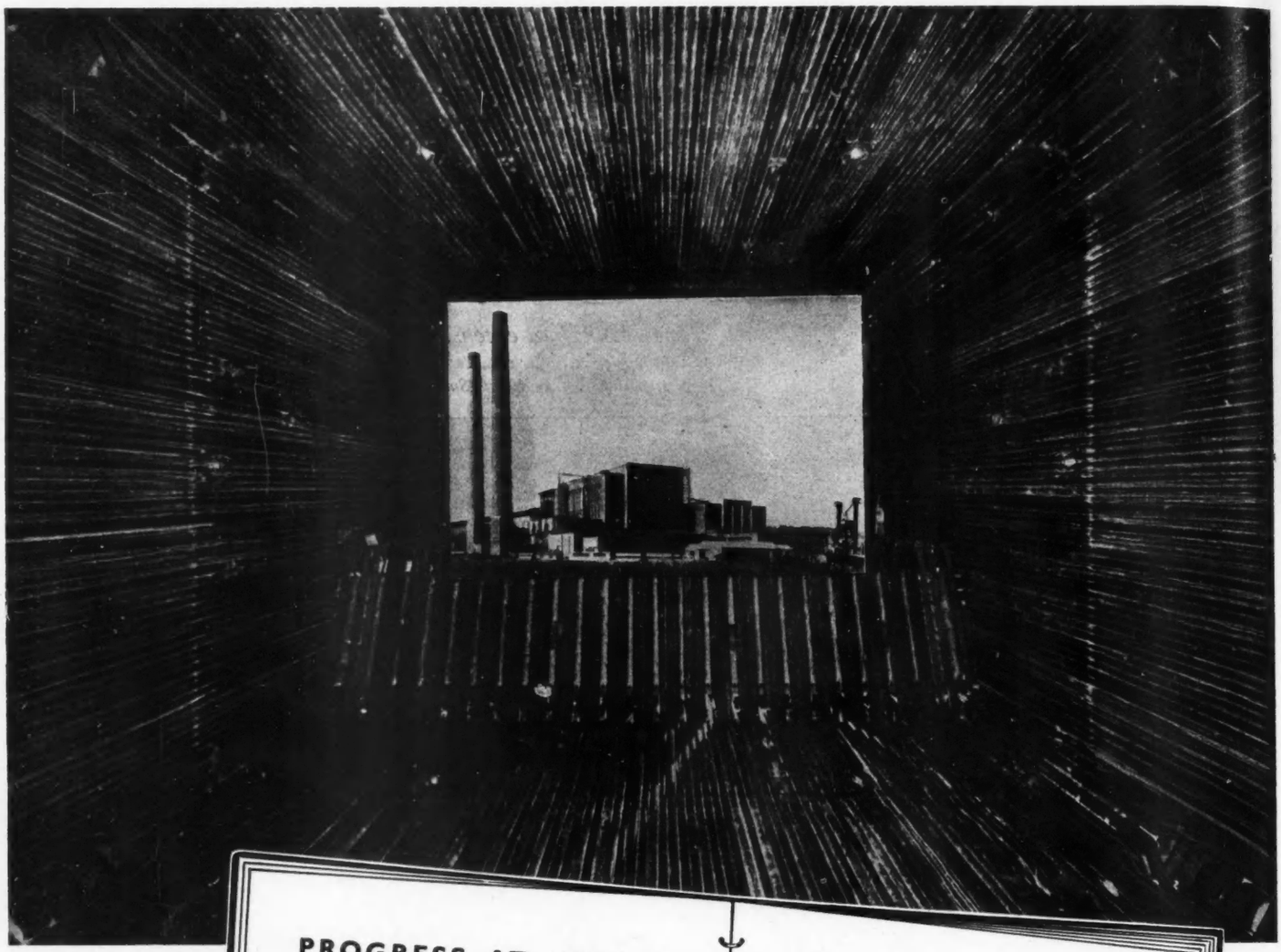
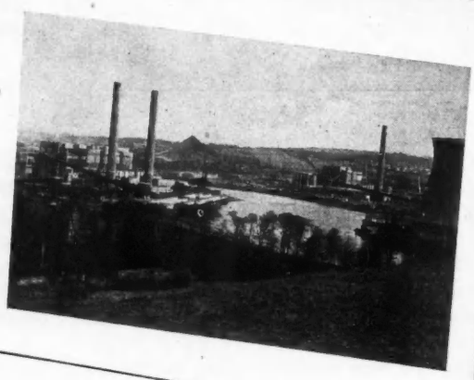


Photographs by kind permission of the Central Electricity Authority. Consultants—Merz & McLellan.

PROGRESS AT STELLA

FOUR of the nine Clarke, Chapman Boilers to be installed at the new power stations on the North and South banks of the Tyne, have been commissioned on schedule.



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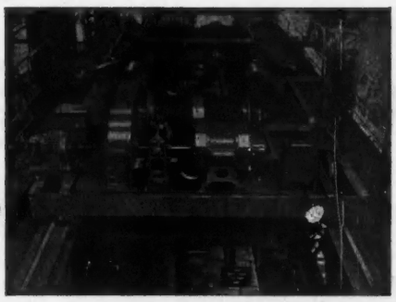
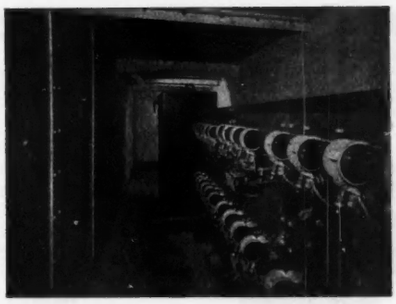
BOOTH OVERHEAD CRANES

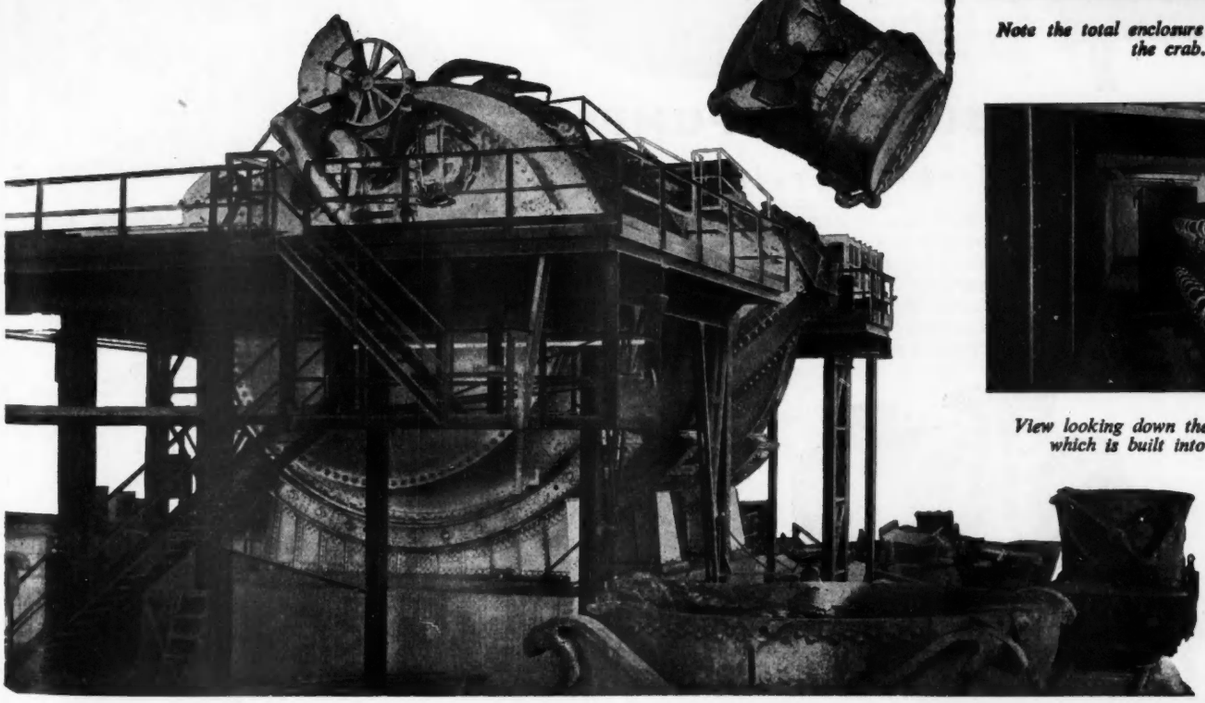
100 ton Ladle Crane supplied recently to a Steelworks in Sweden



Note the total enclosure of all gearing on the crab.



View looking down the contactor house which is built into the girders.



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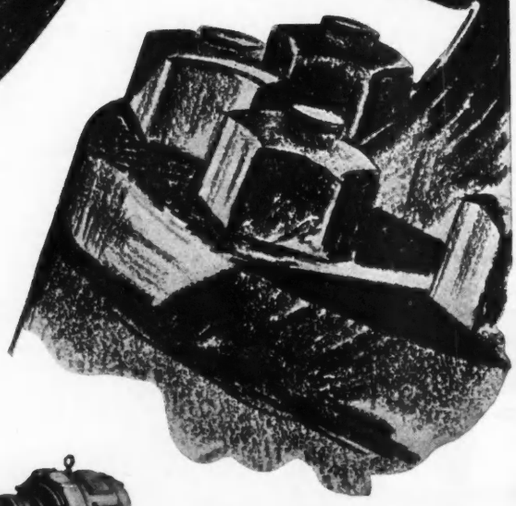

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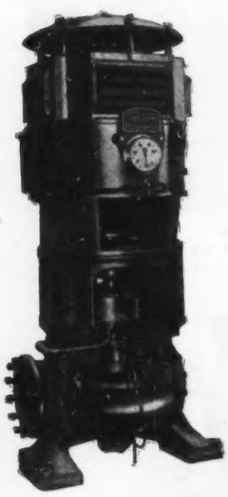

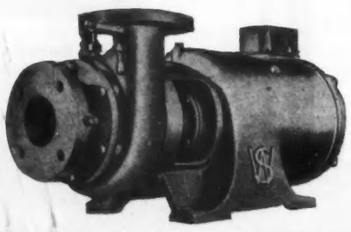

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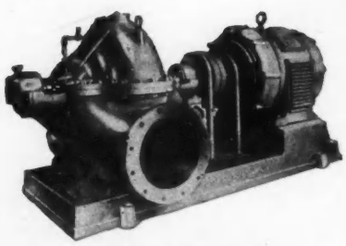

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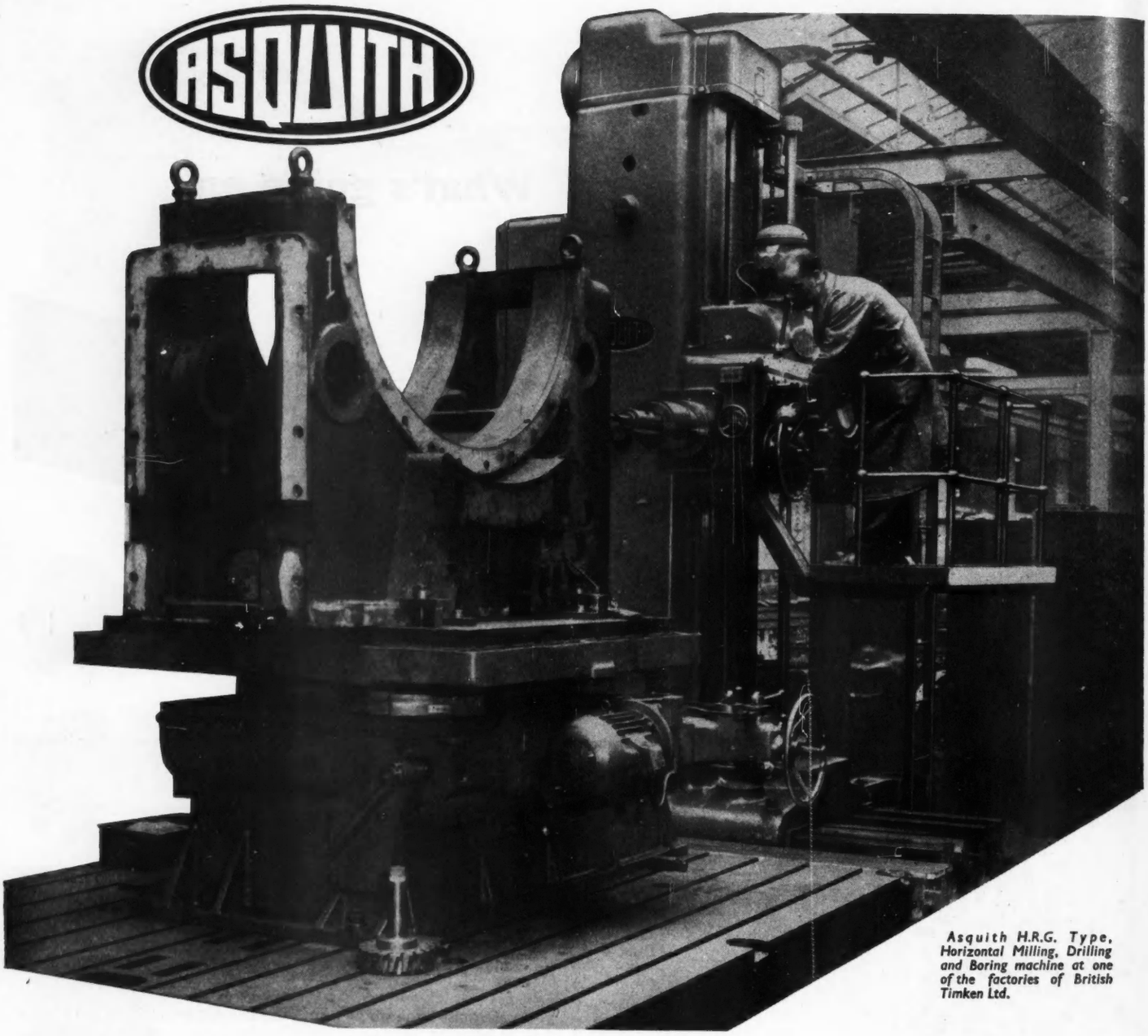

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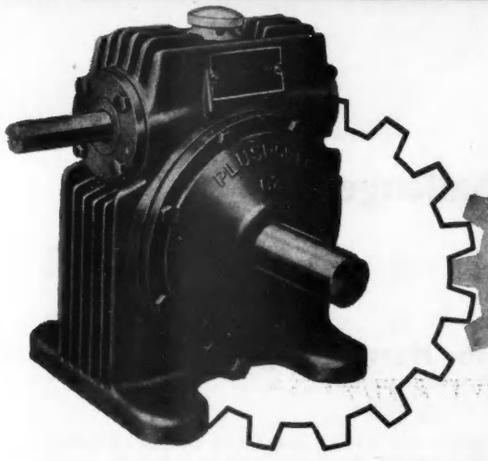

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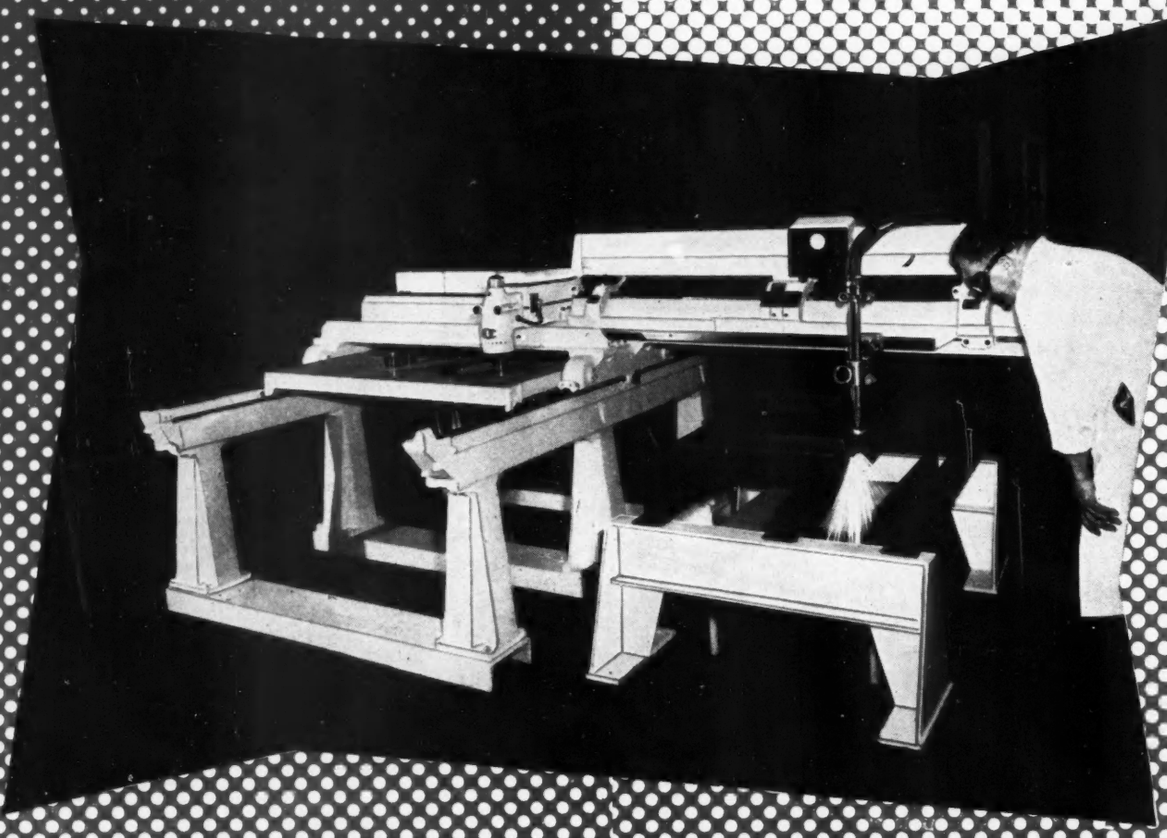

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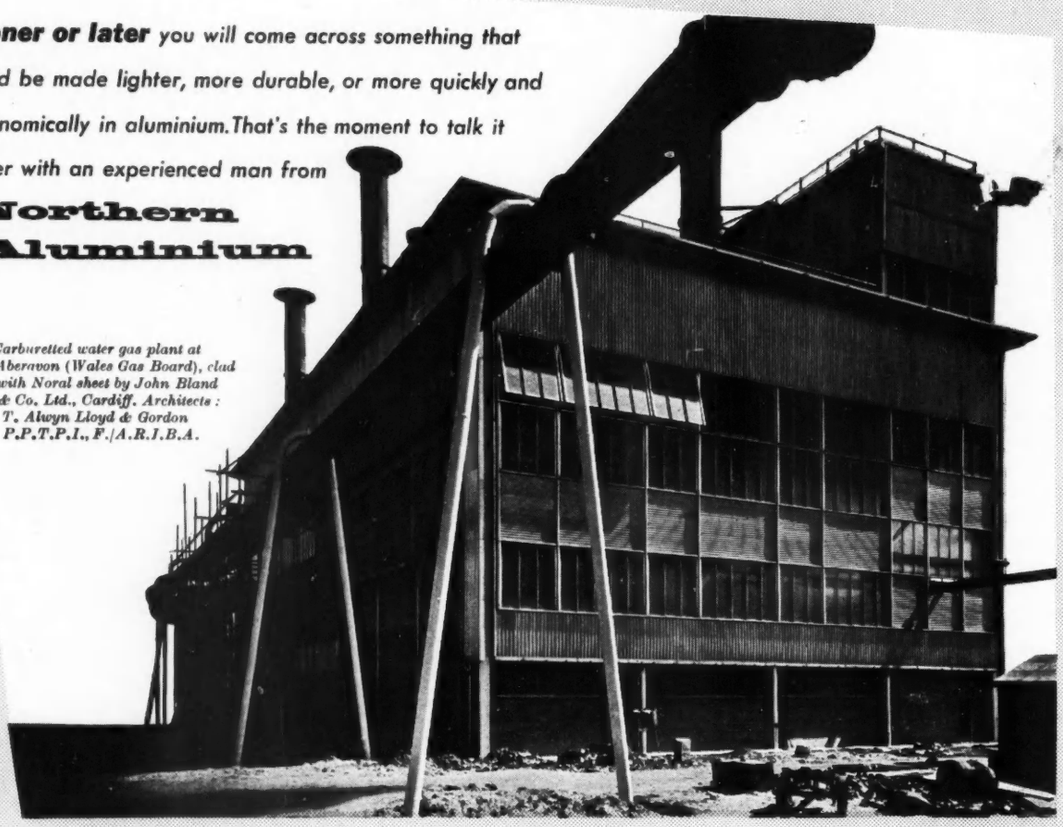

Carburetted water gas plant at Aberavon (Wales Gas Board), clad with Noral sheet by John Bland & Co. Ltd., Cardiff. Architects: T. Alwyn Lloyd & Gordon P.P.T.P.I., F./A.R.I.B.A.

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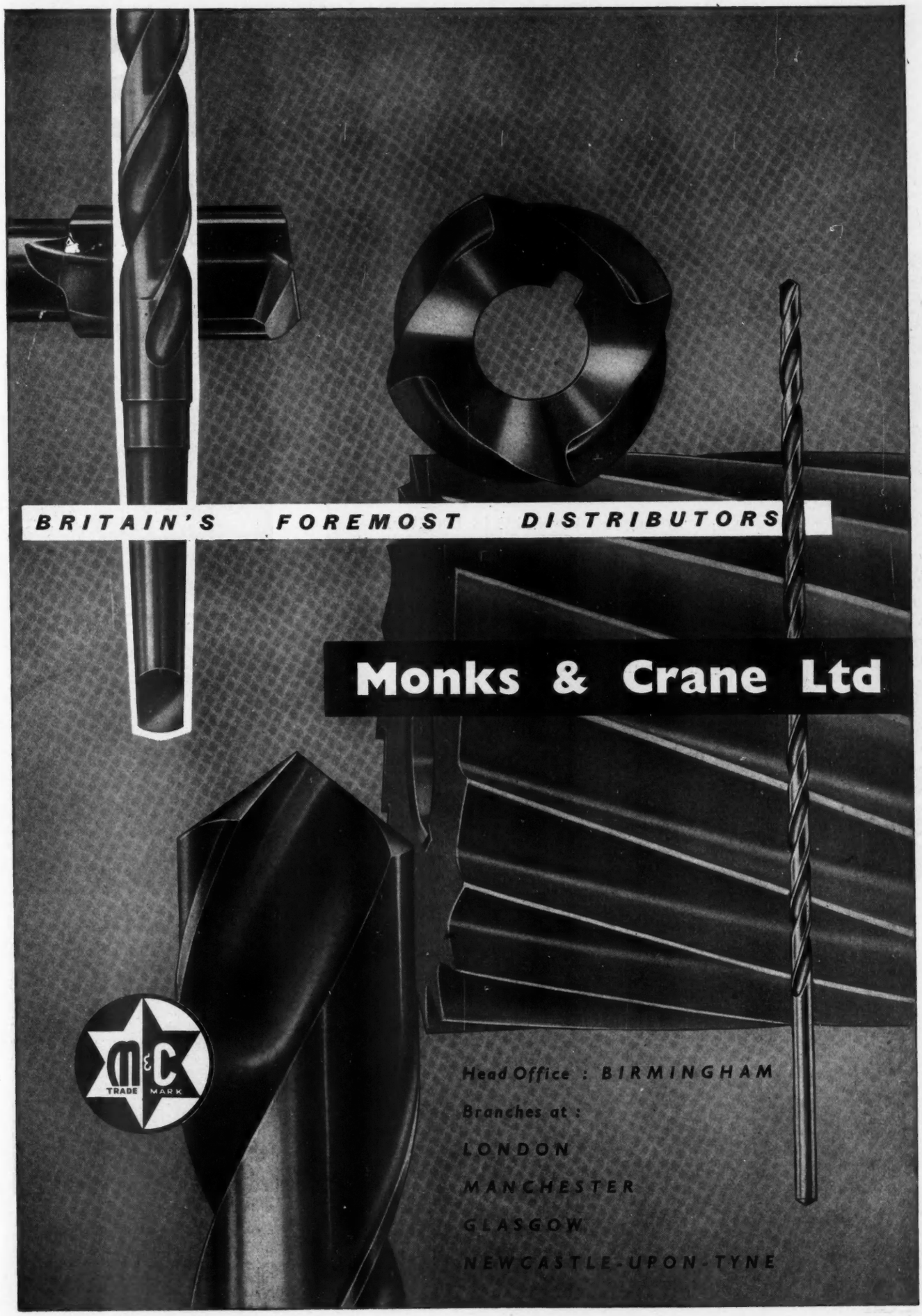
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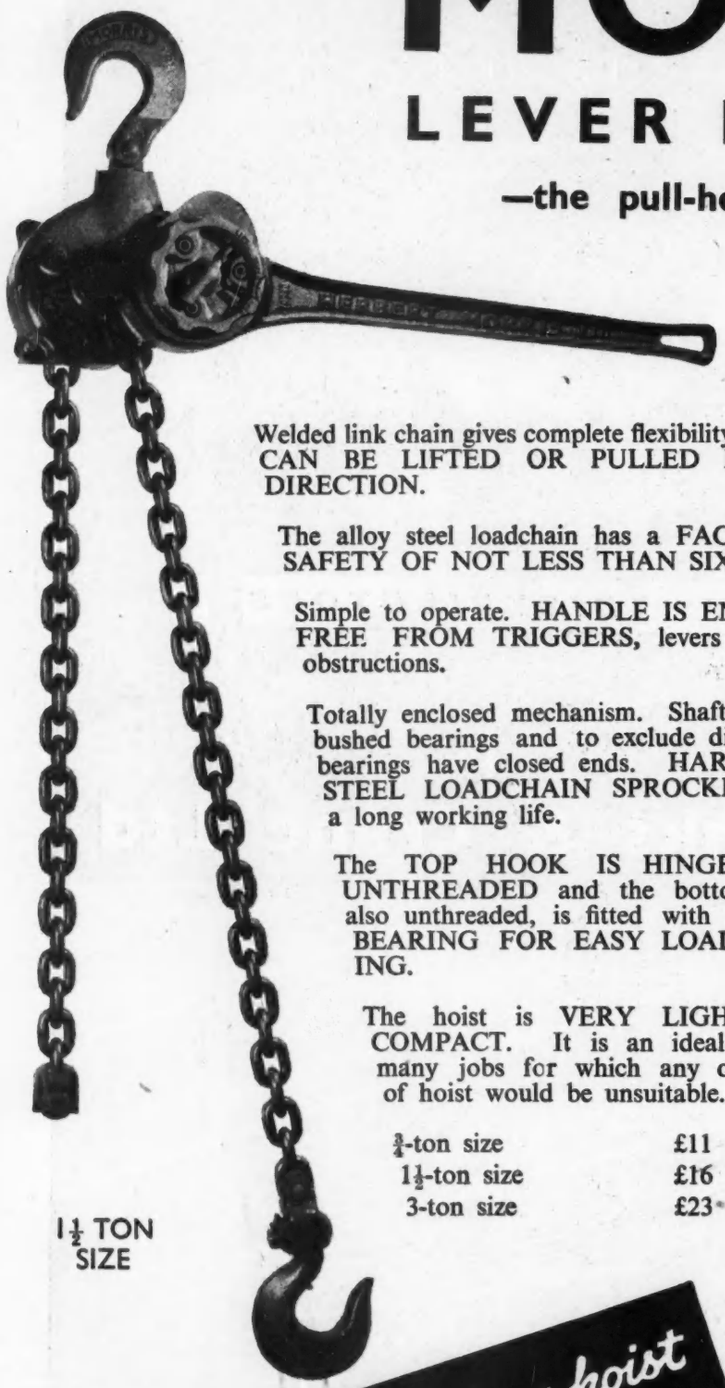

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Simple to operate. HANDLE IS ENTIRELY FREE FROM TRIGGERS, levers or other obstructions.

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No other lever hoist has all these VALUABLE FEATURES

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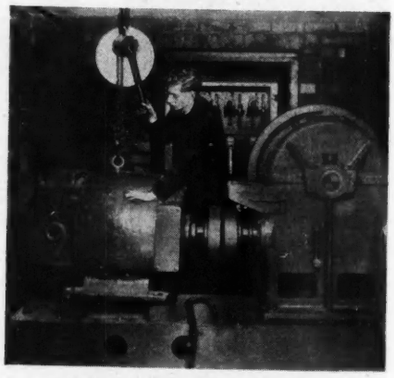
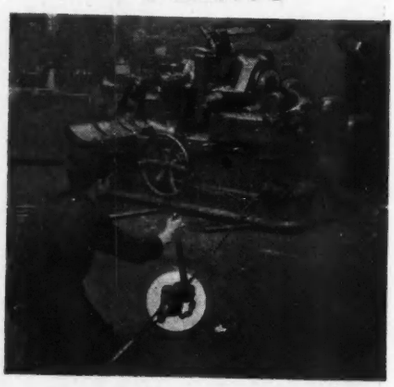


TIGHTENING

PULLING



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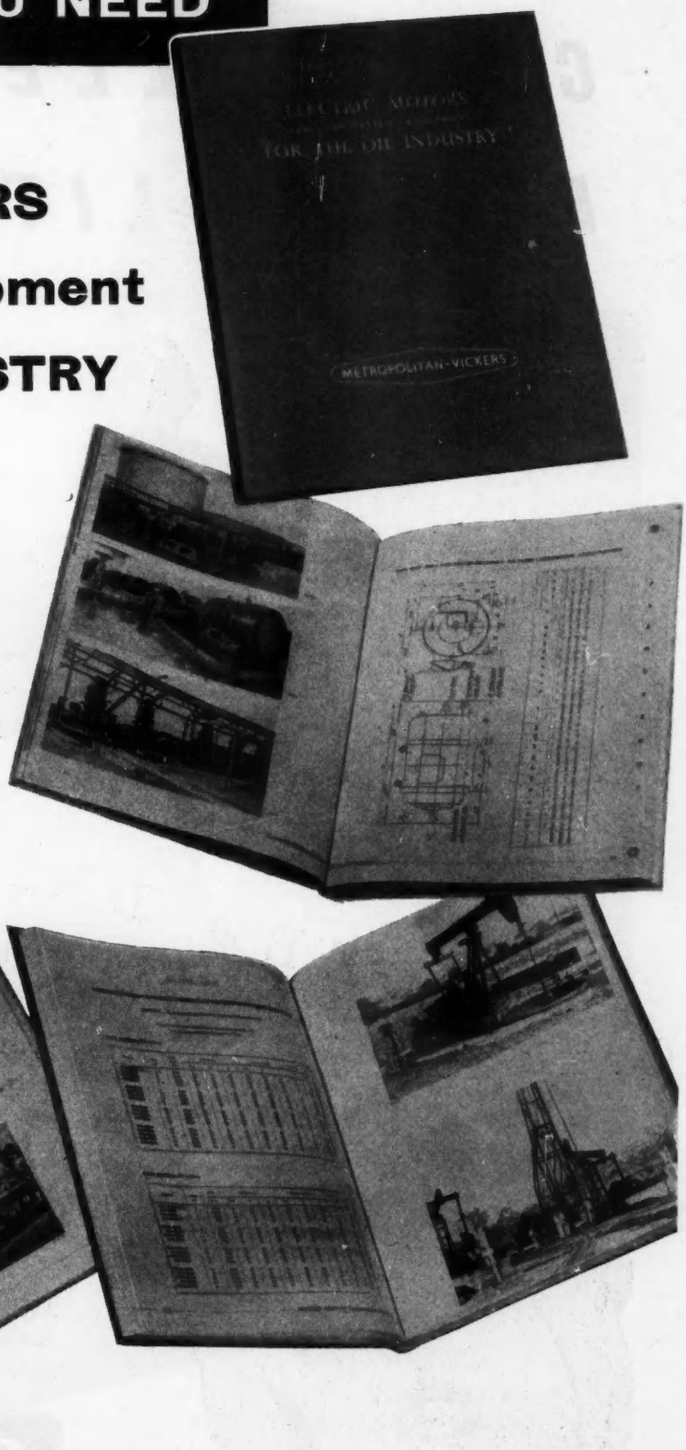

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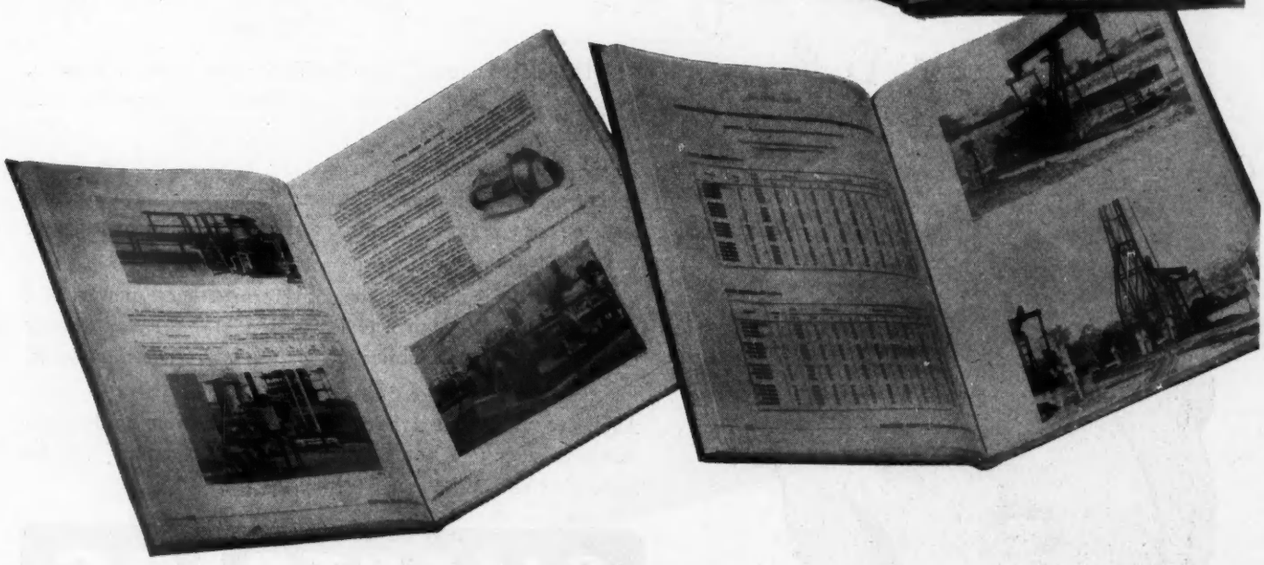

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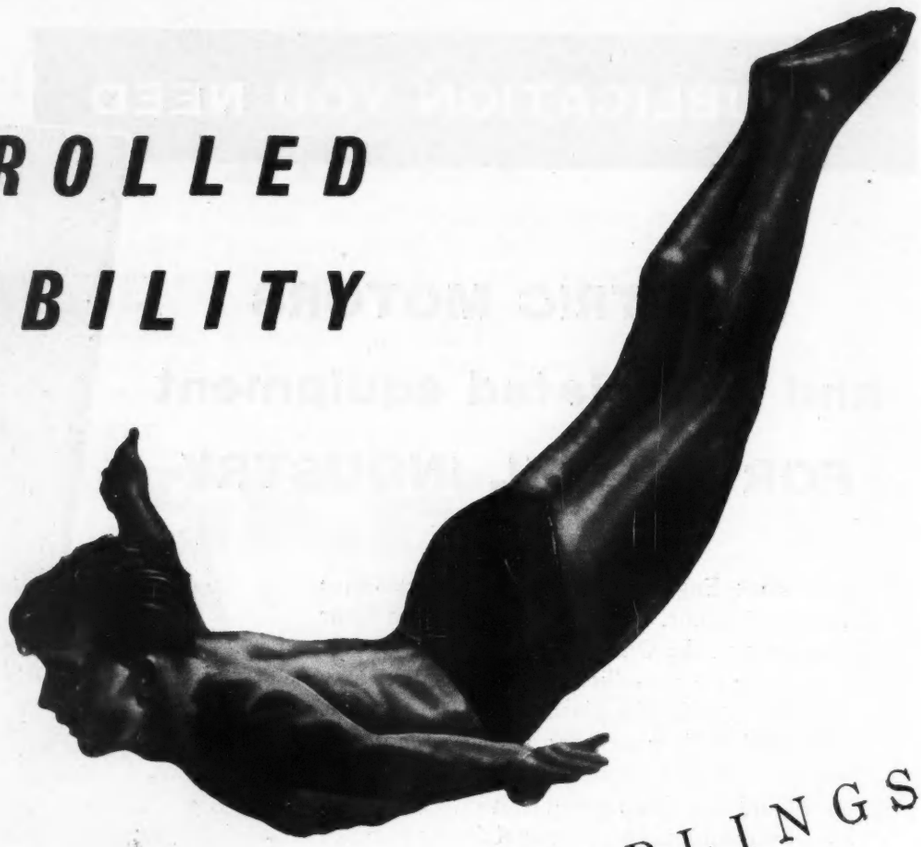

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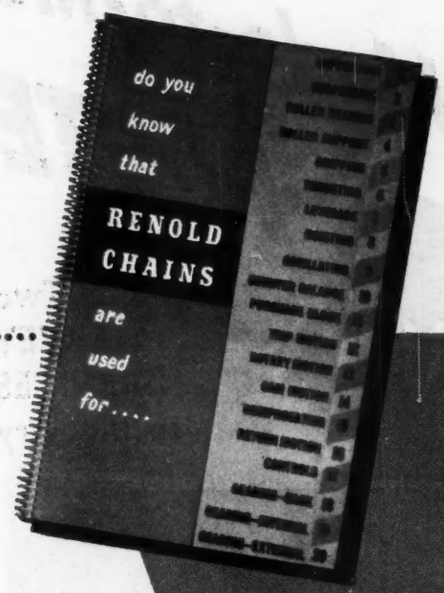

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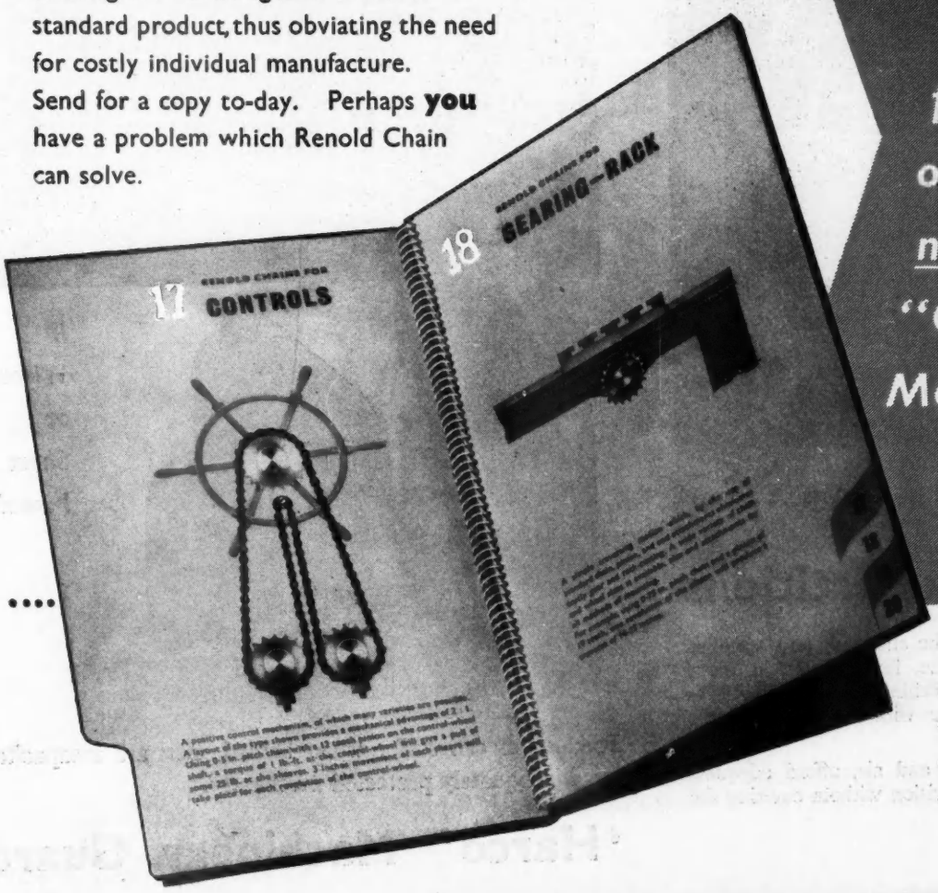

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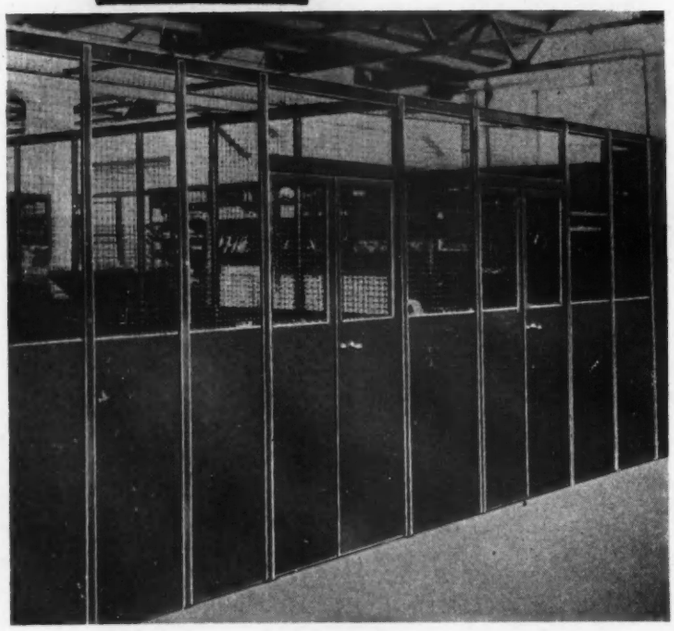

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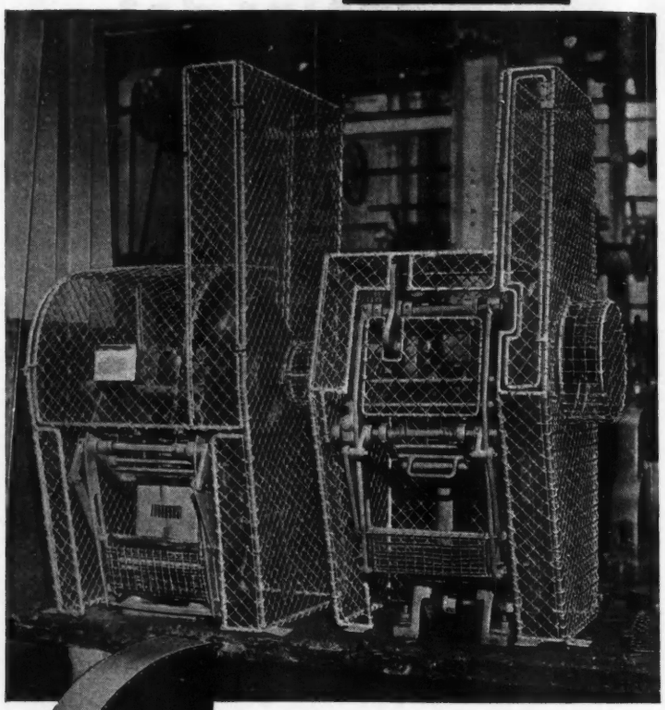

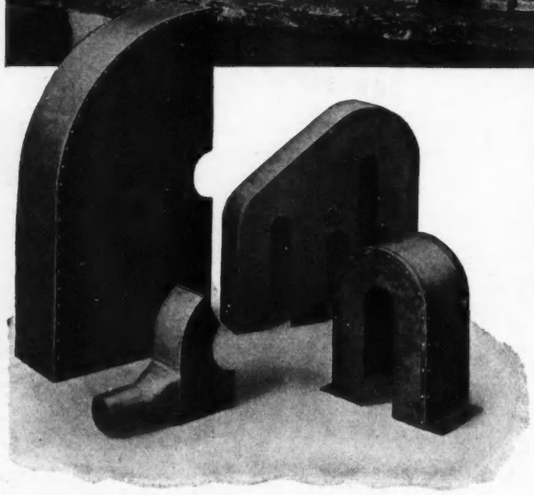

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are accurately designed and substantially constructed to fit your machinery. They can be made of Wirework, Sheet Metal, or a combination of both, and fully conform to Factory Act requirements. 'Harco' Machinery Guards ensure complete protection without interfering with the efficient operation of machinery, and are devised to facilitate maintenance work.

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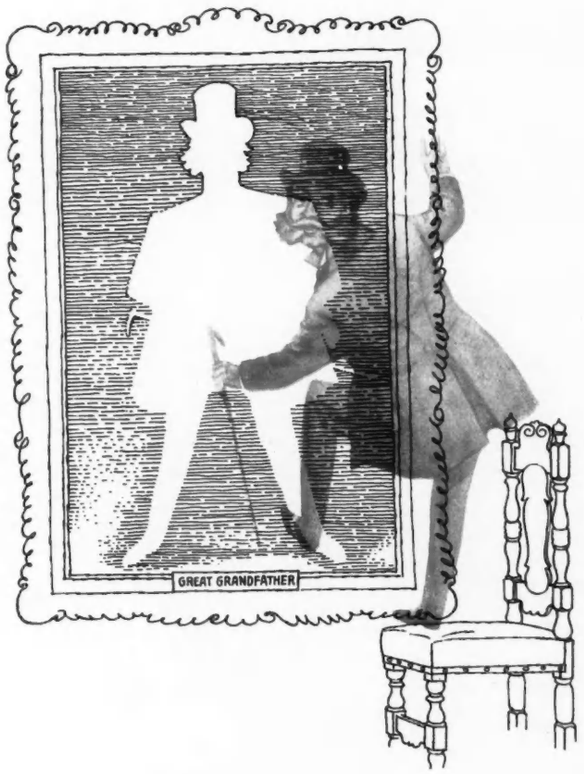

"Well, I've said my piece for the year, gentlemen"

"If I wanted quicker morning starts I would first see that steam got round the mains quicker. This means better air venting of mains. Proper air venting of process plant would shorten my warming-up times.

"Quicker drying, quicker boiling, more production from my evaporators and other process steam units would follow from improved steam quality, and increased heat transfer by the removal of insulating films of water and air.

"By automatic temperature control I could reduce spoilage and labour costs.

"And I would ask Spirax-Sarco to look at my steam plant to see if they could suggest any improvements."

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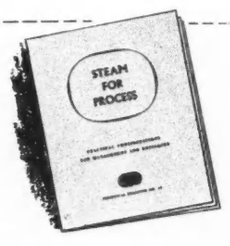

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Photograph of machines by courtesy of W. H. Heywood & Co. Ltd., Huddersfield (Patent Glazing and Roofing Engineers).

Mounting reversed, showing the floor gripping surface.

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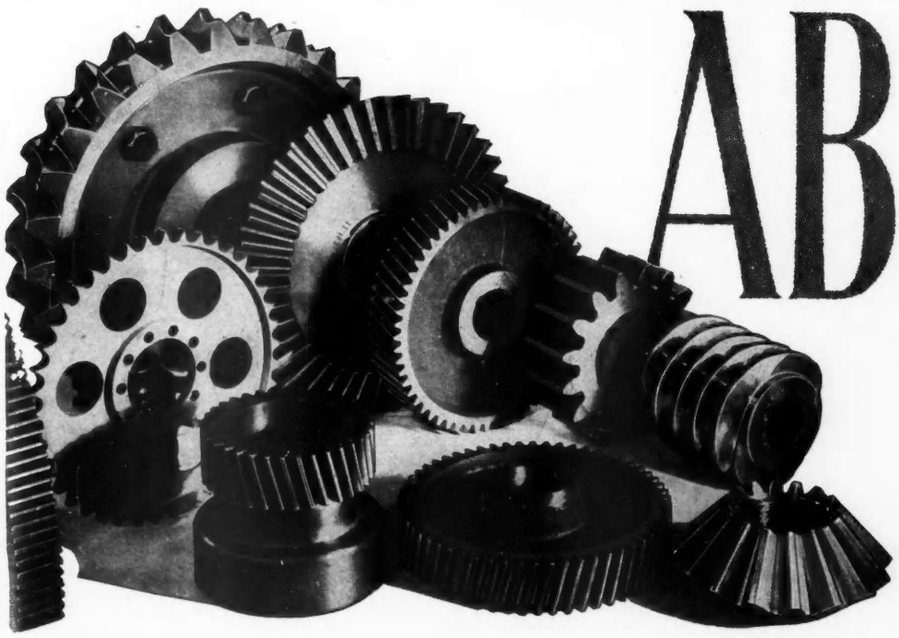

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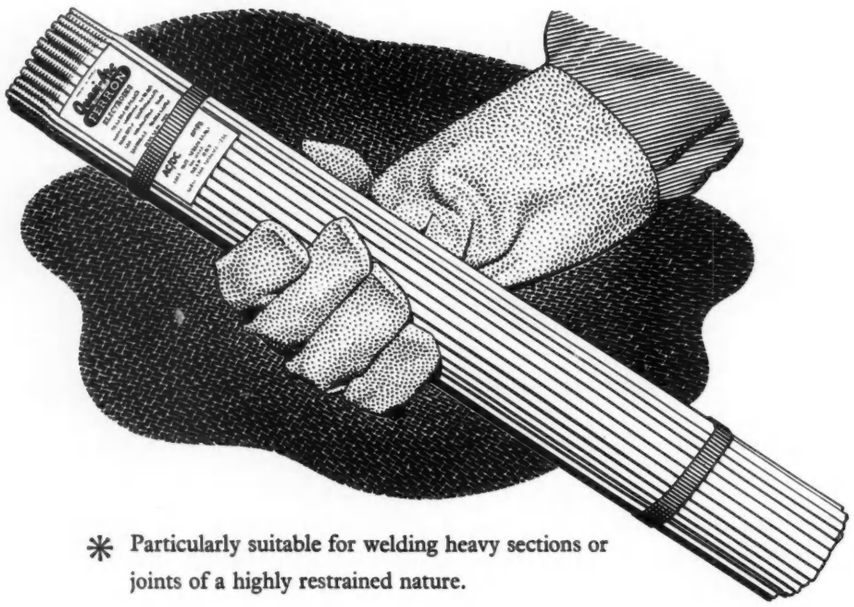

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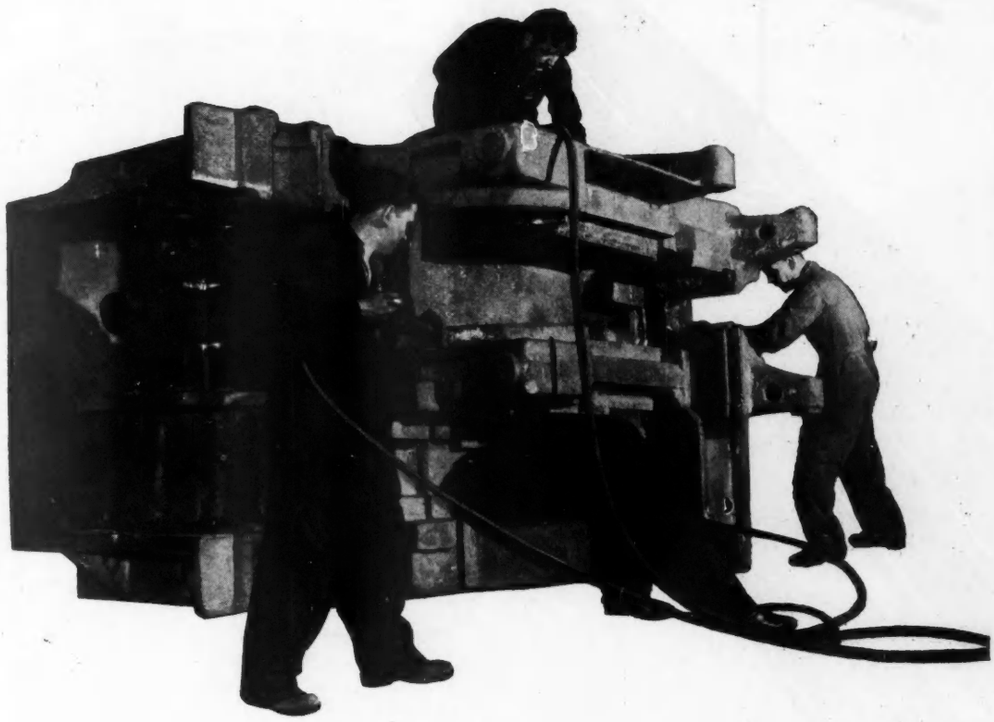
behind the steel casting

DRESSING



The appearance of a steel casting and the amount of 'cleaning up' needed in your workshops, depend a good deal upon the care in dressing that the steel foundry gives to the casting before delivery. Here is a 14-ton steel casting in our Dressing Shop, where extraneous metal, fins, fash, etc., are being removed with pneumatic chisels. The same care goes into every Edgar Allen steel casting, whether it is a small one or a giant like this. As a matter of fact, most of our steel castings are in the range of finished weight of 3 lb. to 3 tons.

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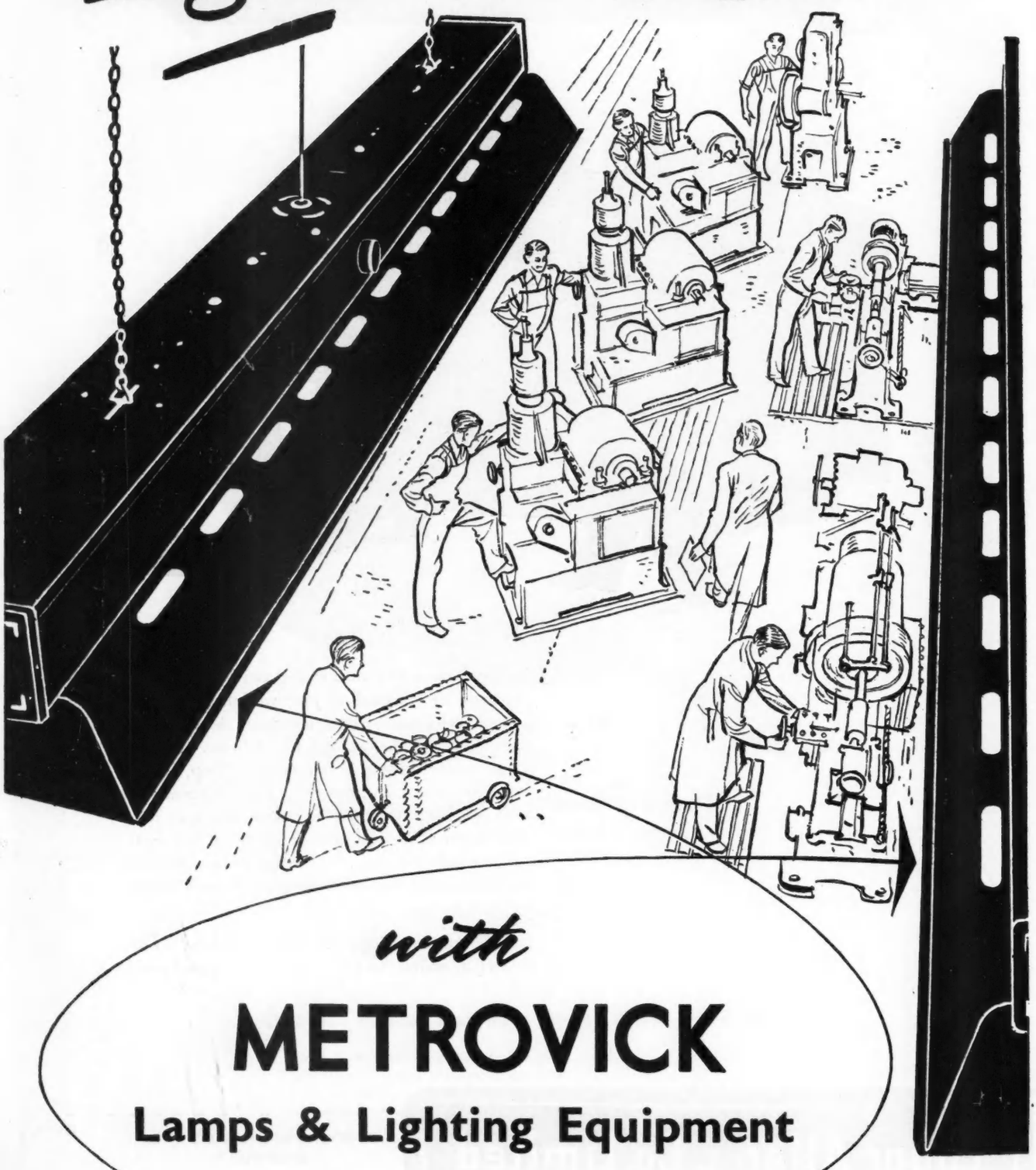

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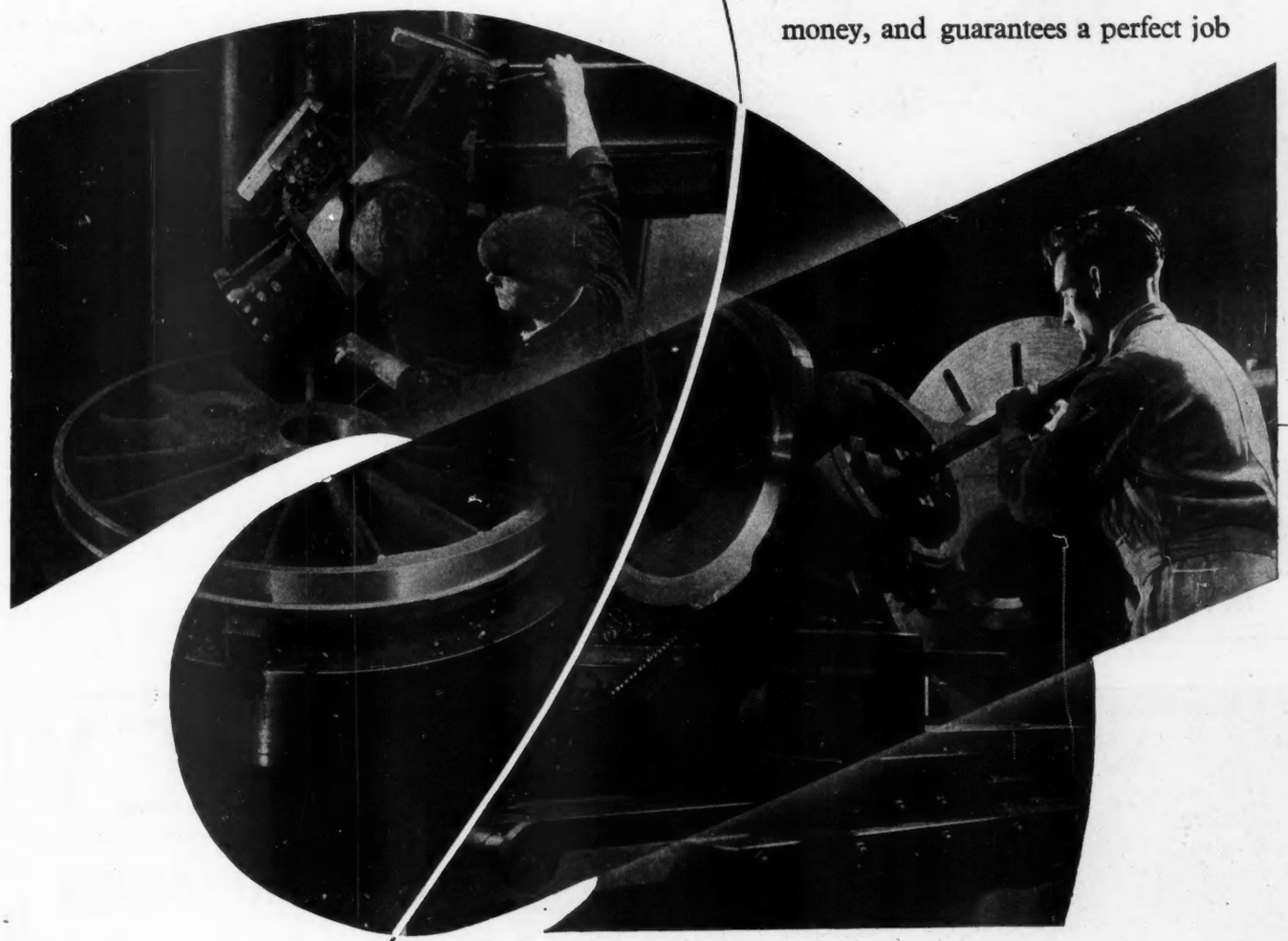

One of the great features of Lloyds foundry is that, in addition to producing the castings, it is superbly equipped to machine them. The advantages are obvious—two major operations are centralised, valuable time is saved, and the customer is spared the expense of transporting rough castings to independent machine shops.

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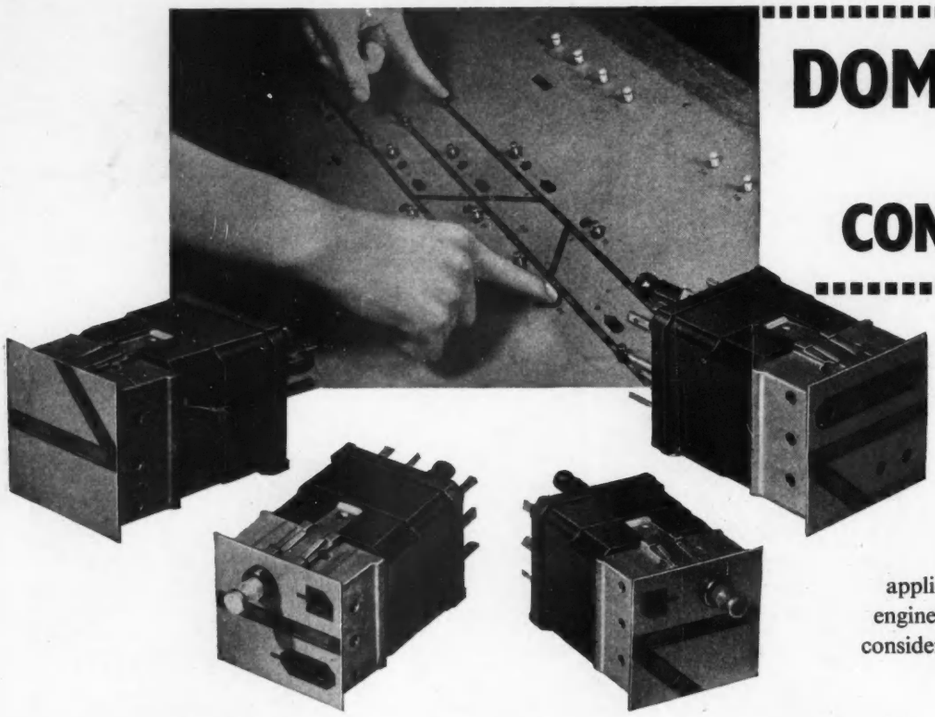

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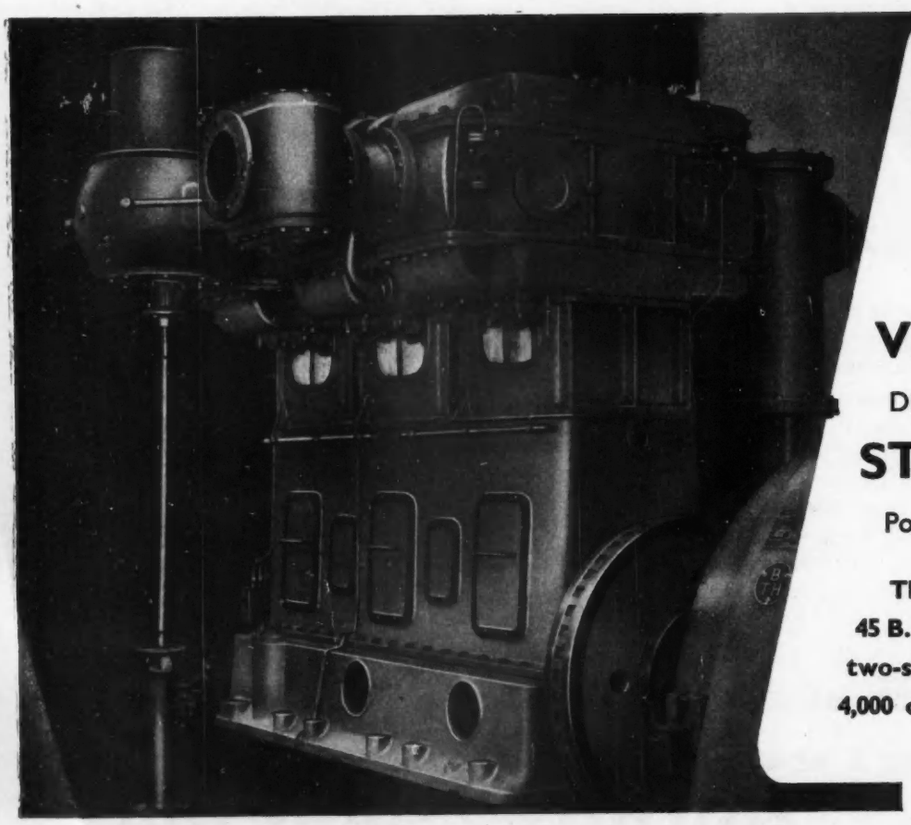

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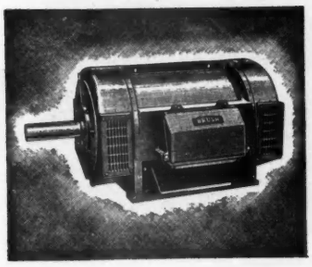

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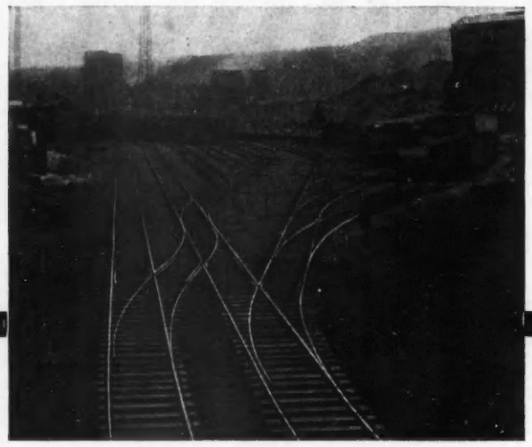

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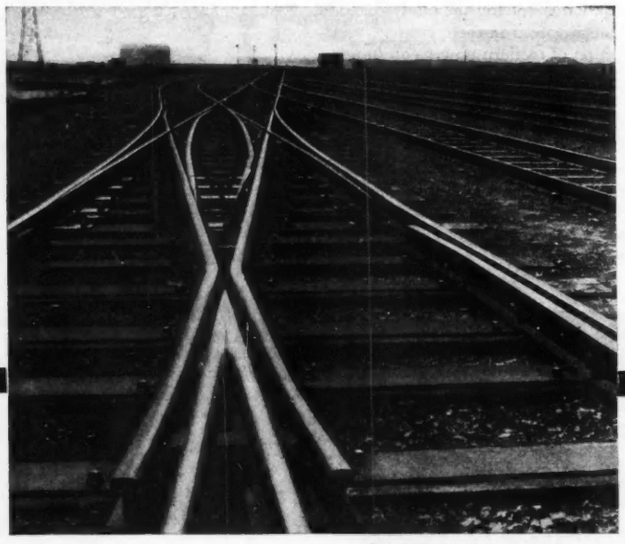

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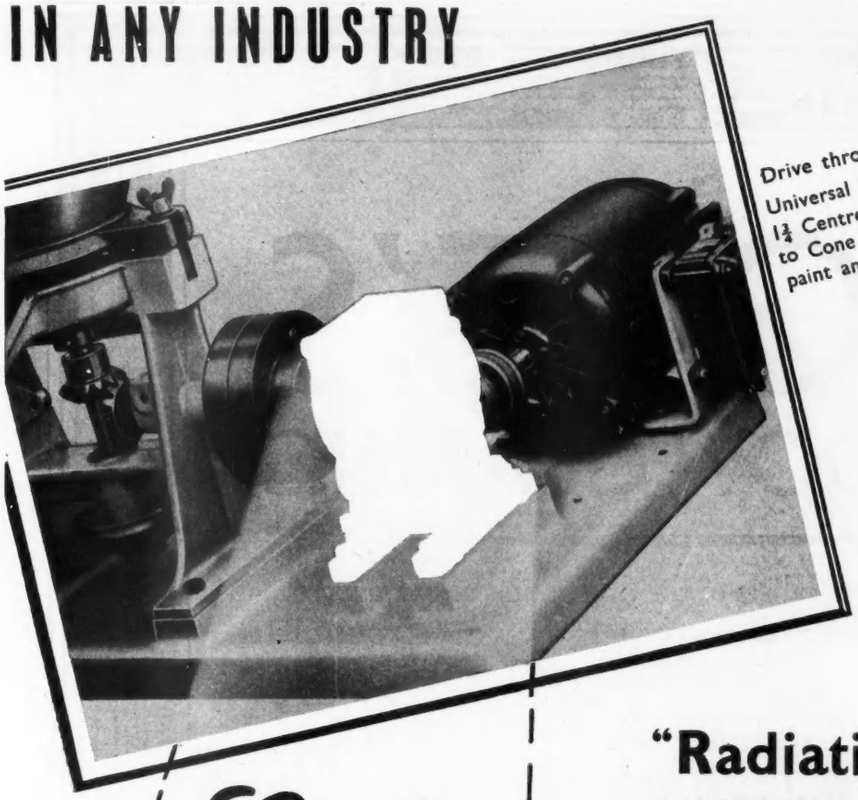

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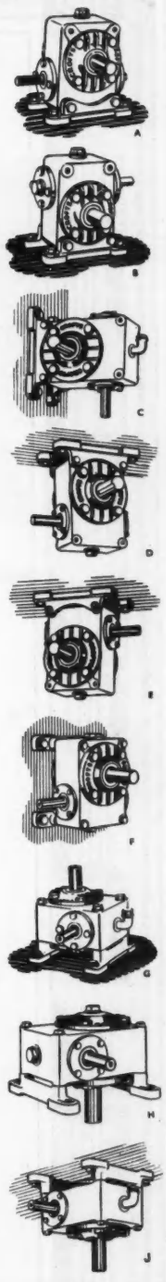

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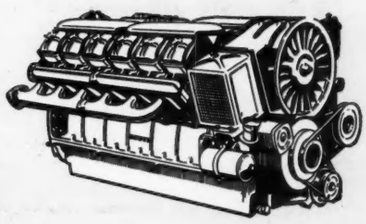

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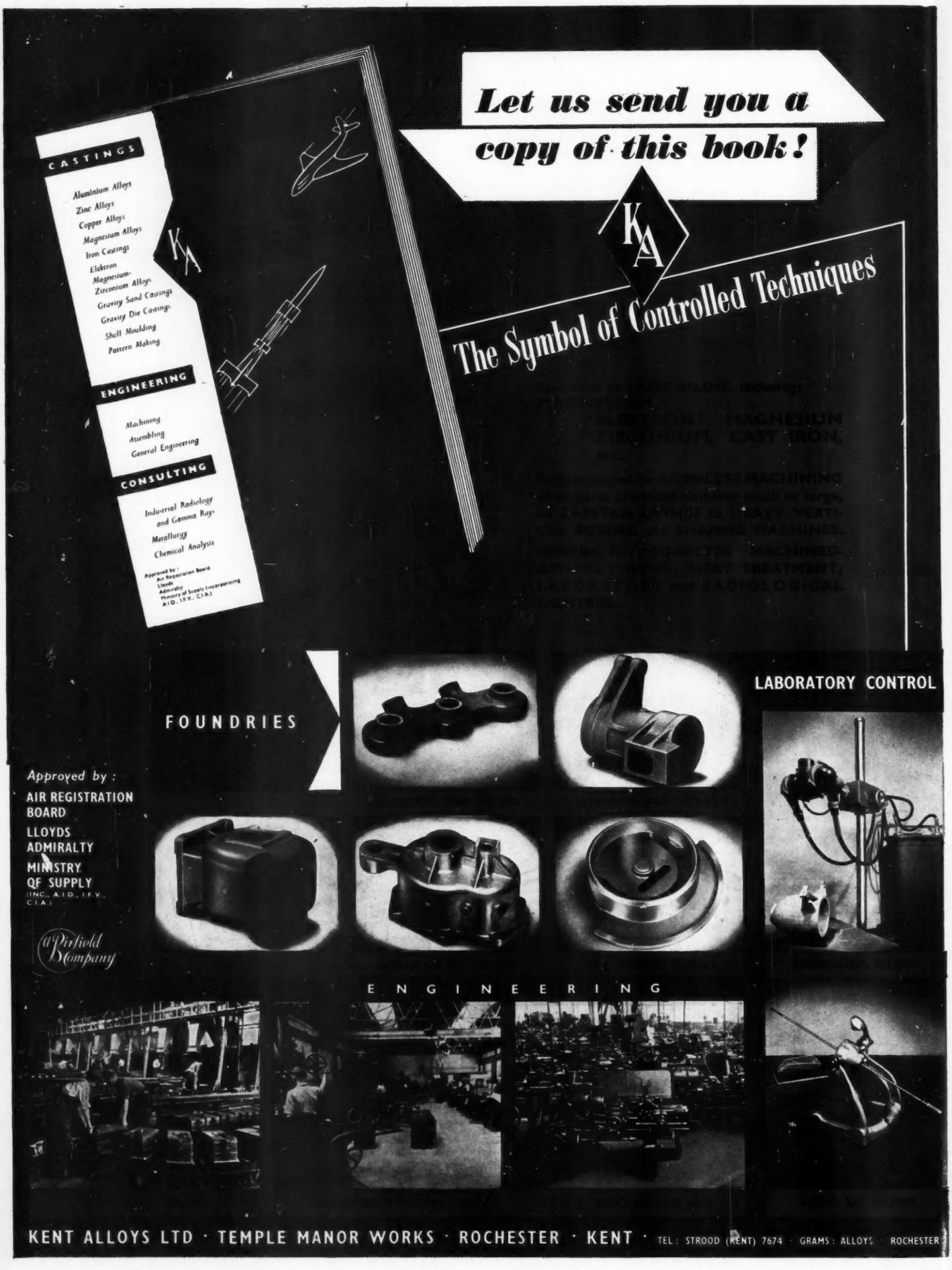
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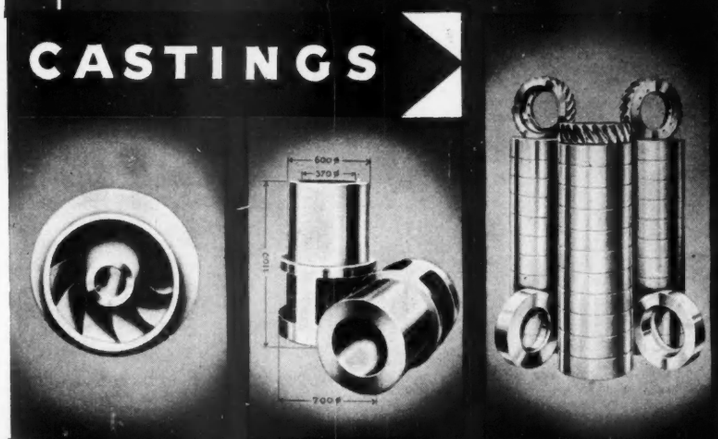

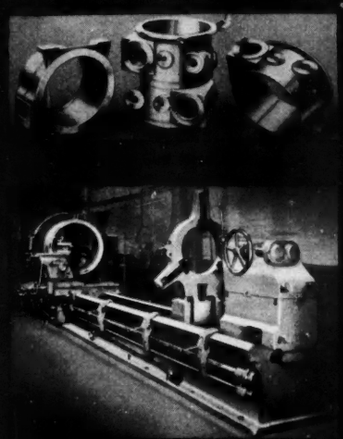

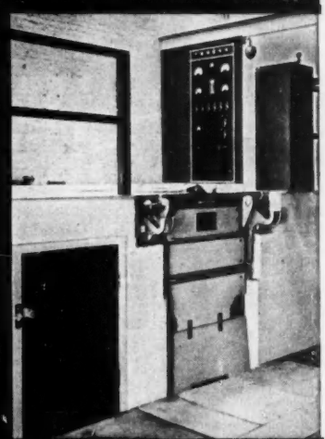

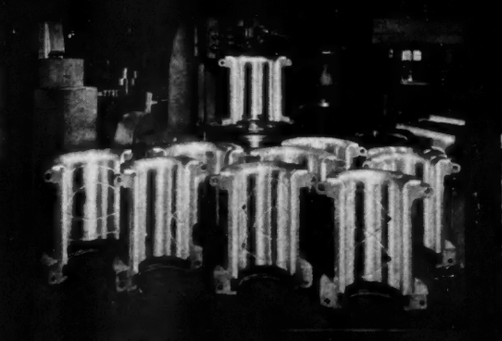

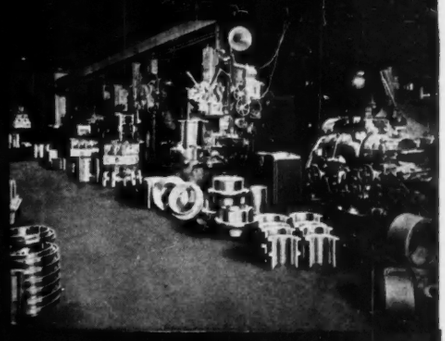

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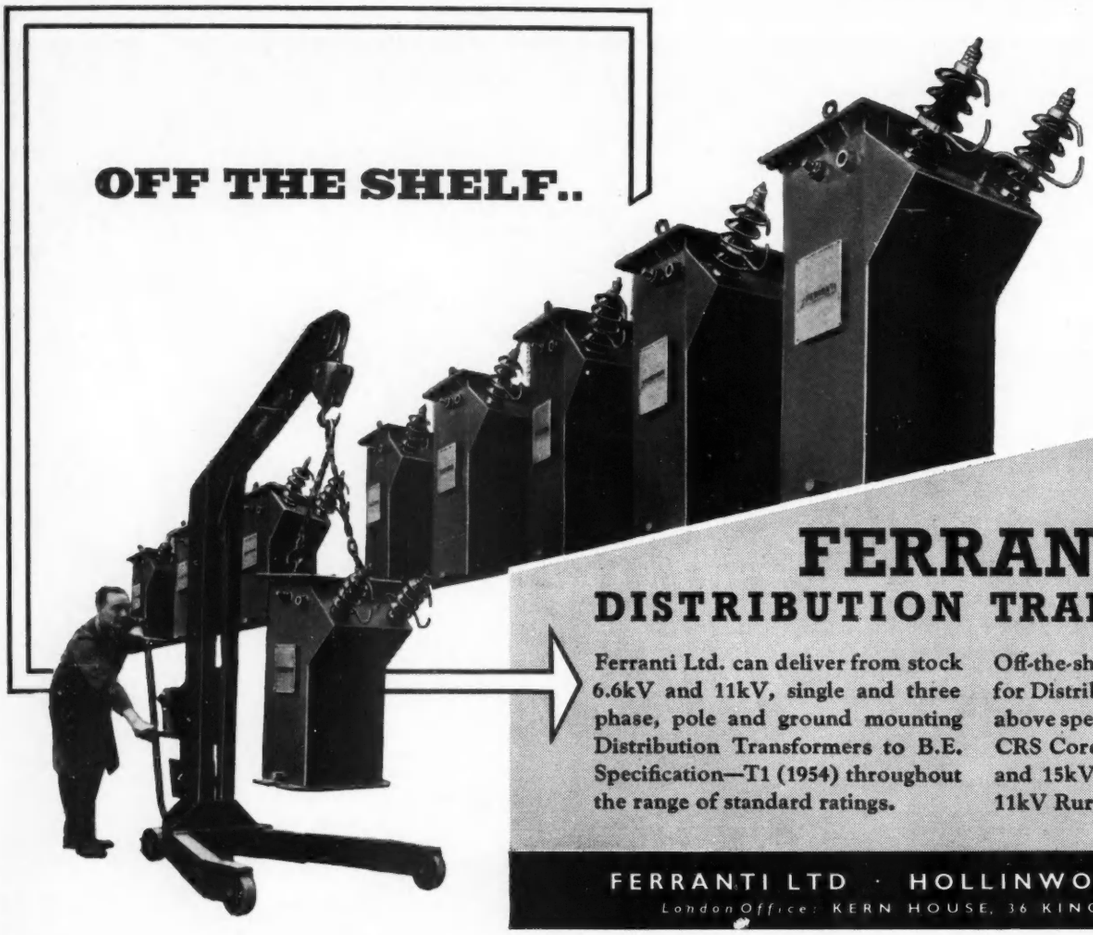

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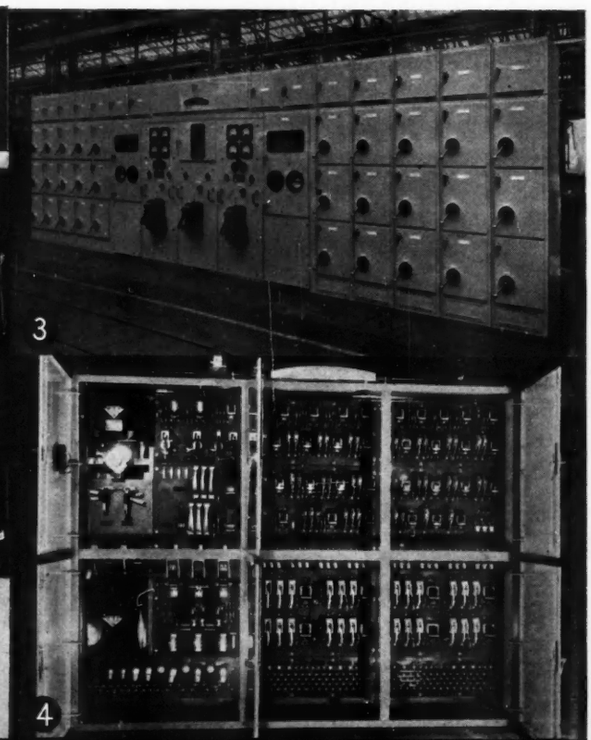

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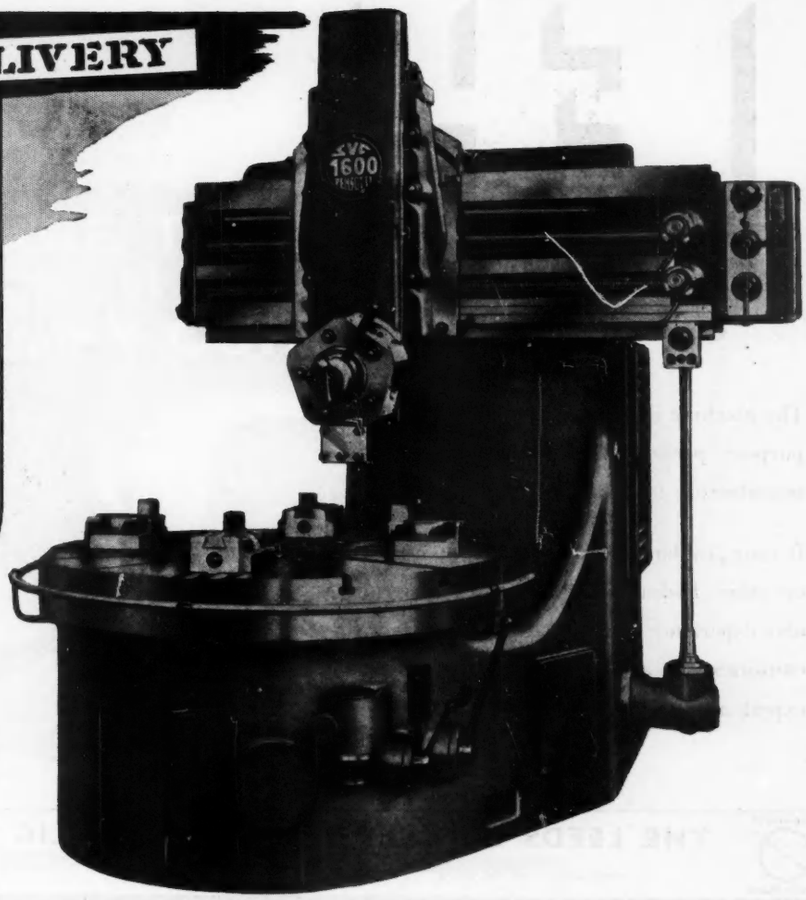

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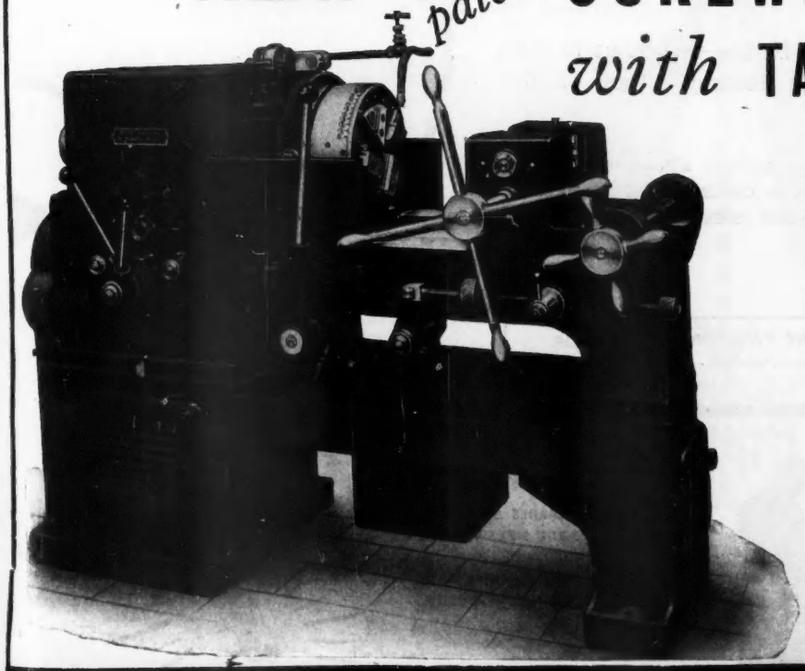

2½ inch Bolt and Pipe Screwing Machine, fitted with our Patent Tangential Die Head. Hand and Automatic Releasing Motion, Automatic Closing Device, Automatic Pump, etc. Motor enclosed in Cabinet leg.

These machines have been specially designed for quantity production work and are capable of extremely fast rates of output.

A full range of sizes is available.

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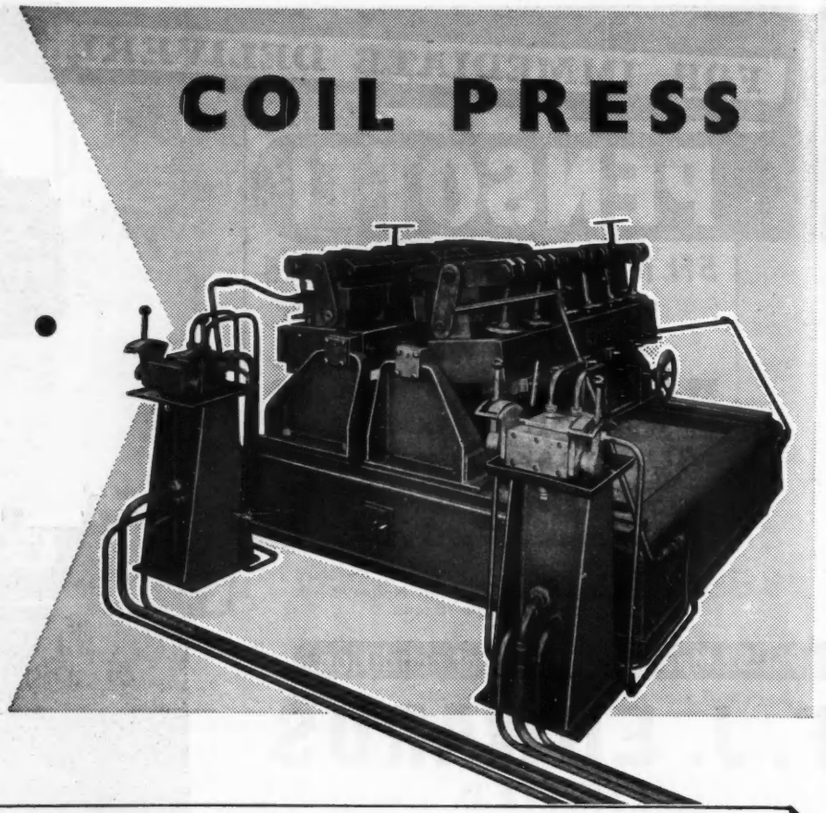
L.E.H.

COIL PRESS



The machine illustrated is typical of the special purpose presses which L.E.H. develop and manufacture to customers requirements.

If your problems include presses, pumps, valves or other hydraulic equipment our resources and experience are at your disposal and your enquiries are assured the most careful and expert attention.

Registered Trade Mark

THE LEEDS ENGINEERING & HYDRAULIC CO. LTD. • RODLEY • LEEDS

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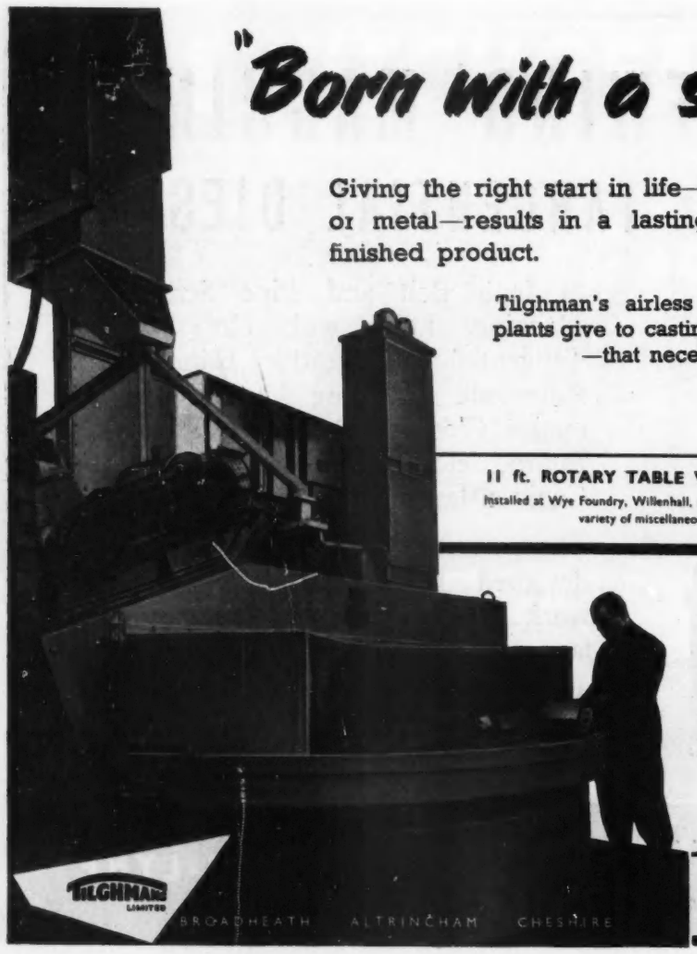
"Born with a silver spoon..."

Giving the right start in life—whether to man or metal—results in a lasting effect on the finished product.

Tilghman's airless abrasive cleaning plants give to castings—large or small —that necessary start.



11 ft. ROTARY TABLE WHEELABRATOR

Installed at Wye Foundry, Willenhall, engaged in cleaning a wide variety of miscellaneous castings.

Wheelabrator plants are produced in types and sizes to suit all general purposes, and in addition, special purpose plants are designed to meet specific requirements.

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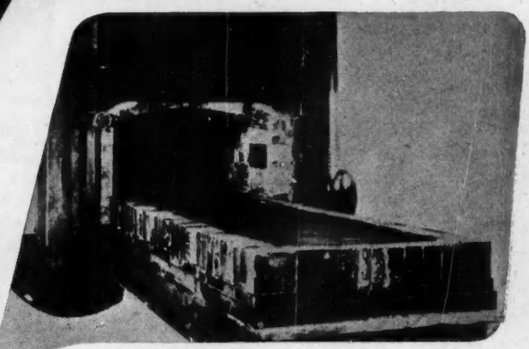
BOGIE TOPS

Examples of another of the many uses for REFRACTORY CONCRETE

Atlas Steel Foundry. Bogie for mould drying stove, topped with Refractory Concrete. Bogie is 25' long and 10' wide, the topping being 6" thick. The door shown is lined with Ciment Fondu insulating concrete



Wm. Jessop & Sons Ltd. Bogie is 15' long by 5' wide topped by 6½" of Refractory Concrete

—Because its monolithic construction eliminates troubles due to displacement of bricks

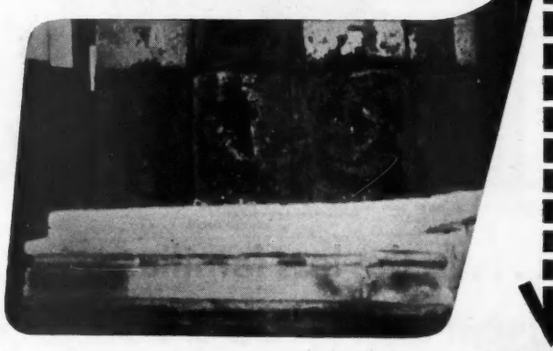
—It will withstand severe thermal shock without spalling

—It is ready for use and of great strength and hardness in 24 hours

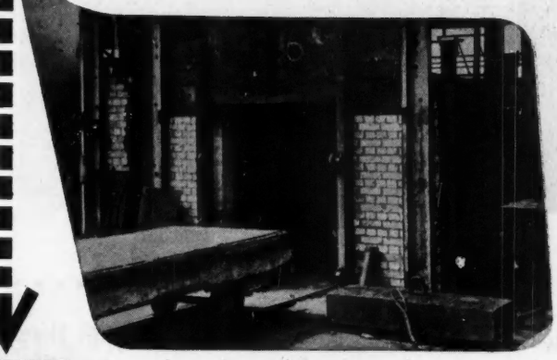
—It has no appreciable drying shrinkage or after-contraction

—It is stable under load up to 1300°C. (2400°F.)

Bogie used at large Northern Foundry, in gas-fired tunnel oven, for annealing malleable iron at 1050°C. Bogie is 7' x 7' and the Refractory Concrete decking is 12" thick.



Crossley Bros. Ltd. Bogie for gas-fired annealing oven operating at 650°C. The door is also lined with Refractory Concrete



REFRACTORY CONCRETE
the adaptable Refractory material made with crushed firebrick and CIMENT FONDU

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CONCRETE ROCK-HARD WITHIN ONE DAY

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You are invited to write for further details and photographic examples

AP 3-1306

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OFFICES, ASSOCIATED COMPANIES AND AGENTS THROUGHOUT THE WORLD

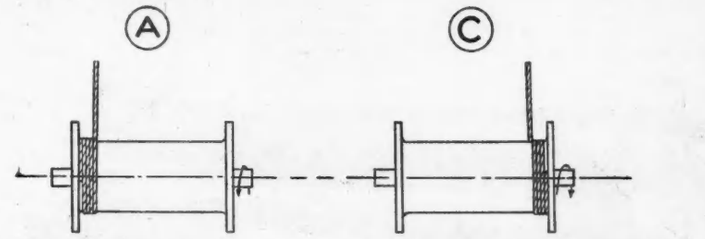
NUMBER THREE

Give your Ropes a chance

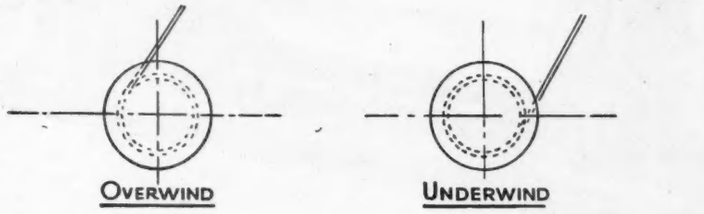
WINDING A WIRE ROPE ON AN UNGROOVED DRUM

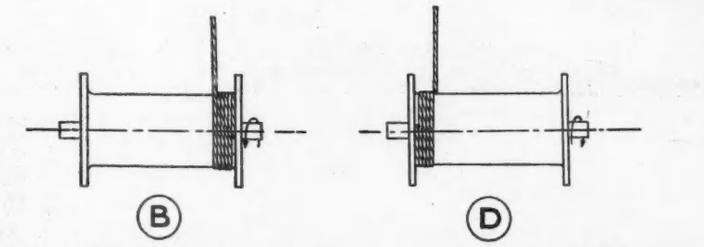
Care must be taken when specifying a wire rope which is to be used on an ungrooved drum. The direction of the lay, i.e., whether right-hand or left-hand lay, largely controls the regularity of the spooling on the drum. The correct lay is controlled by the method of winding and the position of the rope anchorage on the drum.

The sketches shown below detail the correct directions of lay for the various methods of winding. These details apply equally to ordinary lay and Lang's lay.



(A) **OVERWIND** Spooled left to right—Use right hand lay rope. (C) **UNDERWIND** Spooled right to left—Use right hand lay rope.





(B) **OVERWIND** Spooled right to left—Use left hand lay rope. (D) **UNDERWIND** Spooled left to right—Use left hand lay rope.

N.B.—It is preferable to arrange your lay-out to use right hand lay rope as this type is normally available from stock.

FLEET ANGLE

The Fleet Angle is the angle created at the point of intersection of a line drawn from the inside edge of the drum flange and along the centre line of the rope lead, and a line drawn from the centre of the drum and at right angles to it. This angle is formed at the lead pulley. On a crane fitted with a groove drum the angle should never exceed 4° and on a crane fitted with a flat faced drum the angle should be between ½° and 2° maximum. Should this angle exceed the above figures in the case of a flat faced drum deterioration will take place in the rope due to side wear and slip; deformation and bruising of the rope will be the result. In the case of a grooved drum, the rope will bear very heavily on the sides of the grooves both of the drum and the pulley and the rope and the sides of the grooves will be rapidly worn.

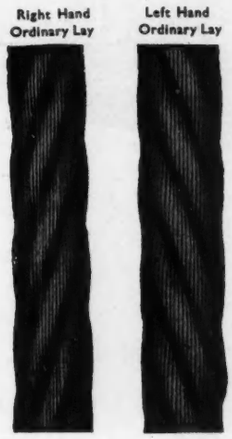
To ensure the correct Fleet Angle the following formula may be useful in finding the height of the lead pulley or the width of the drum, when one of these two measurements is known.

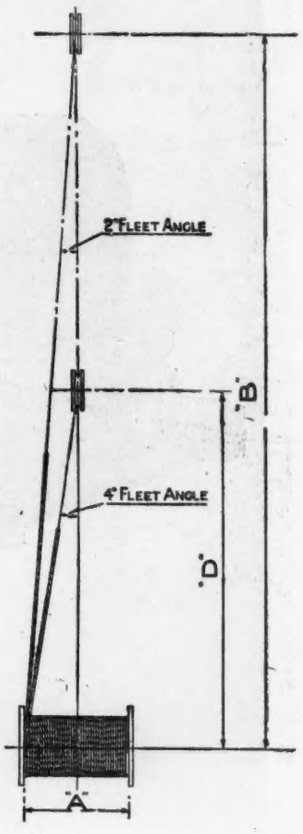
FLAT FACED DRUMS—
Maximum Fleet Angle 2°
Let A=Width of Drum.
B=Height from centre of drum to centre of Pulley.
C=·07 Maximum (Constant).

$A = B.C.$ $B = \frac{A}{C}$ $C = \frac{A}{B}$

GROOVED DRUMS—
Maximum Fleet Angle 4°
Let A=Width of Drum.
D=Height from centre of drum to centre of Pulley.
=·14 Maximum (Constant).

$A = D,C.$ $D = \frac{A}{C}$ $C = \frac{A}{D}$





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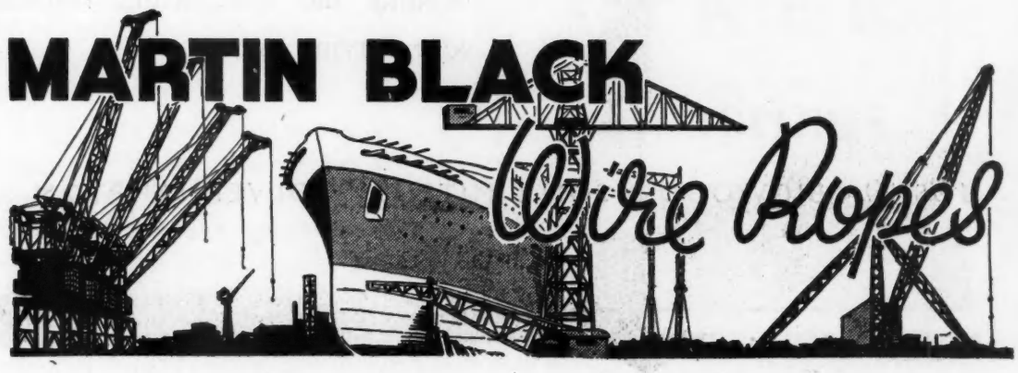
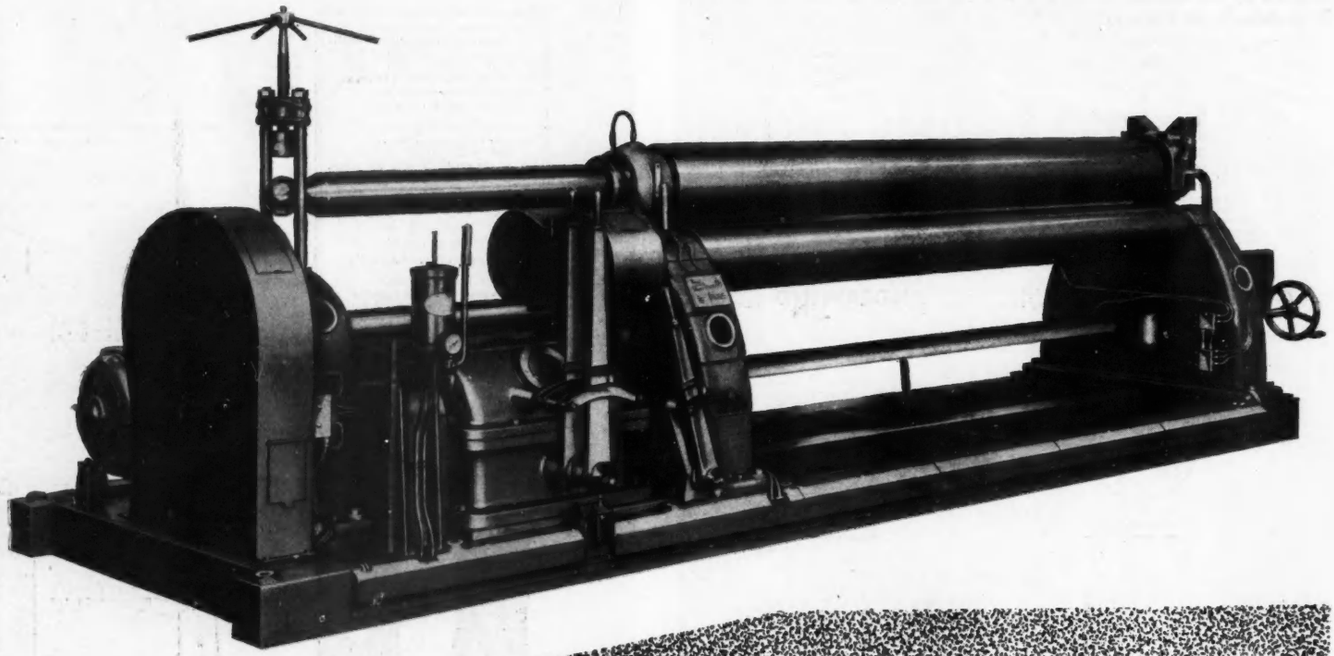
'Phone: WHITLEY BAY 20803.



BIGWOOD

PLATE ROLLS

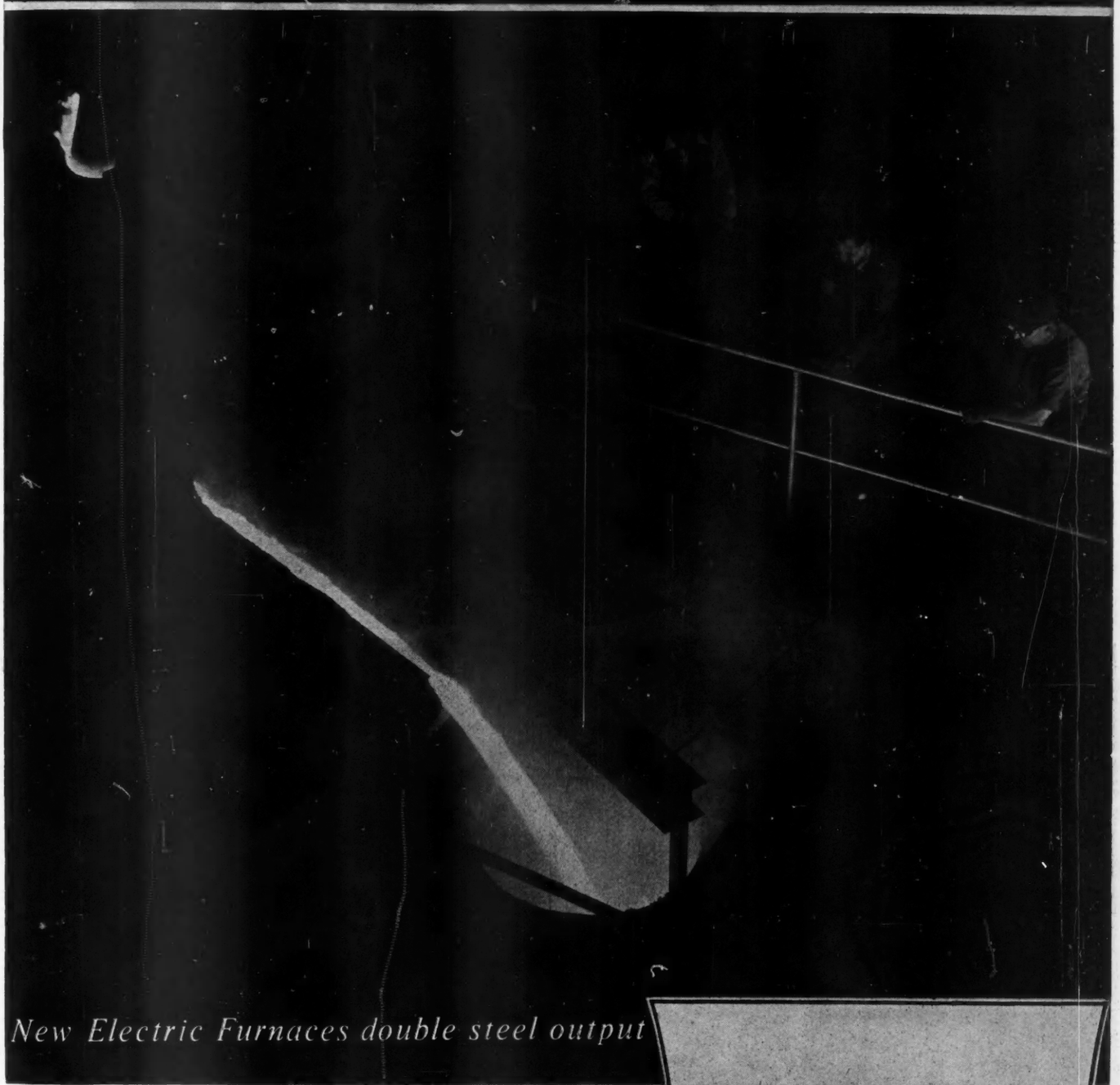


Pyramid and 4-roll pinch type plate bending machines for $\frac{1}{4}''$ to $\frac{1}{2}''$ plate. Length according to needs. 4-roll and 5-roll combined plate bending and straightening machines. Plate edge curving presses.

JOSHUA BIGWOOD & SON LIMITED · WOLVERHAMPTON · ENGLAND

B.131

Parker Progress



New Electric Furnaces double steel output

From your first contact with Parker Foundry you experience a personal attention and an interest in your design problems that is indeed refreshing in these days of "take it or leave it". To this understanding service Parker now add greatly increased production facilities. New machines, new processes and 25,000 sq. ft. of extra floor space, now help to make even better castings, faster. The new electric furnaces for instance have 9" dia. electrodes and transformer capacity of 2,500 kVo — to permit optimum melt control.

They double the production of low carbon steel of high magnetic permeability, and pearlite manganese steel of high tensility and exceptional wearing characteristics. *Always Consult Parker first, before you finalise on steel castings.*

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steel castings

Manganese, Carbon & Alloy Steel.

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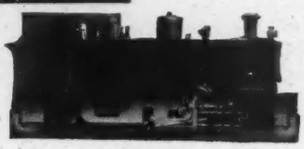
OIL-FIRED

18" x 26" 0-6-0 weight in W.O. 51 tons

OIL-FIRED

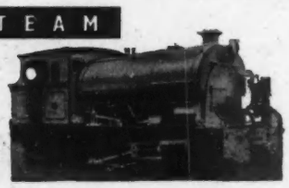


13" x 16" 0-4-2 weight in W.O. 29 tons

FIRELESS

12" x 18" 0-4-0 weight in W.O. 18 tons

STEAM



14" x 22" 0-4-2 weight in W.O. 42 tons

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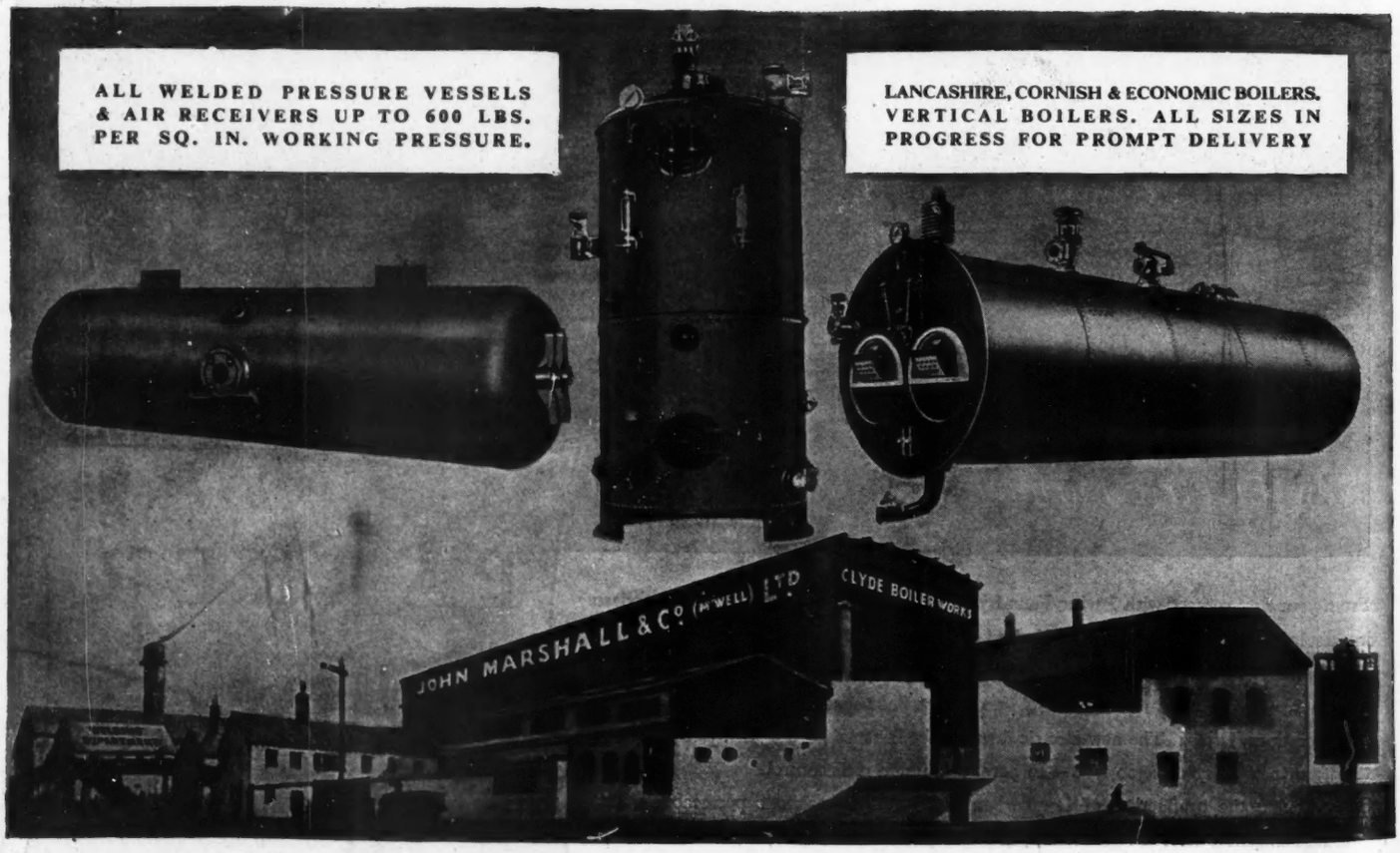

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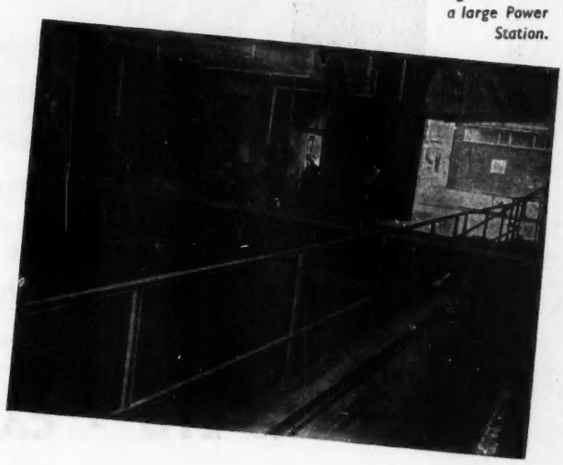

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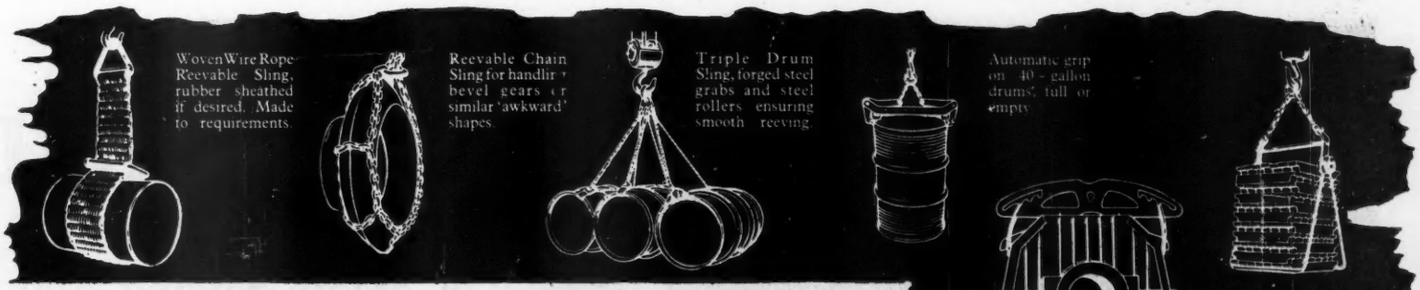
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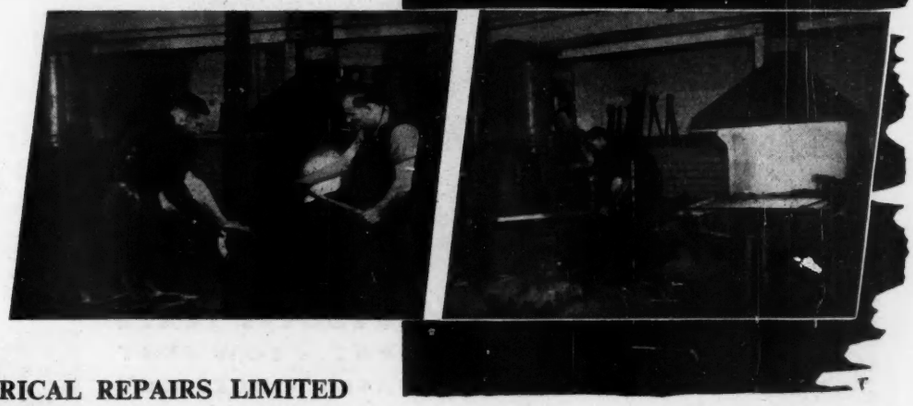
These illustrations give you some idea of our resources —your request for further information will give more— and we shall be interested to receive details of your lifting problems. Our Area Managers—Lifting Tackle Services—will give immediate personal attention to your enquiries.



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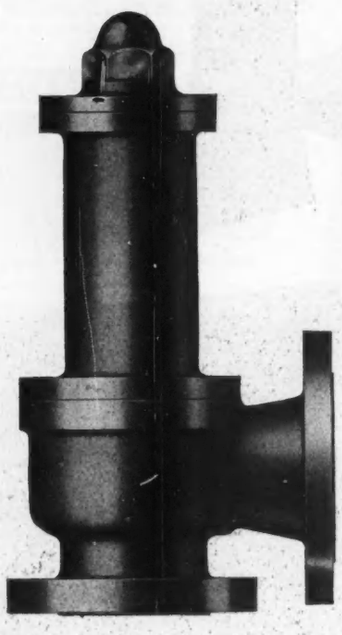

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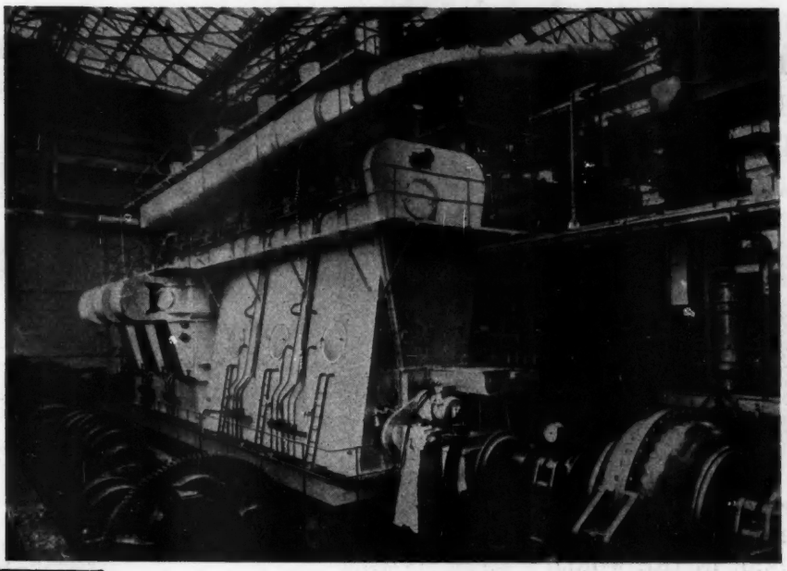


DOXFORD DIAPHRAGM ENGINE ON TEST.
The photograph was taken whilst the engine was running at 103 r.p.m. and developing 7750 b.h.p.

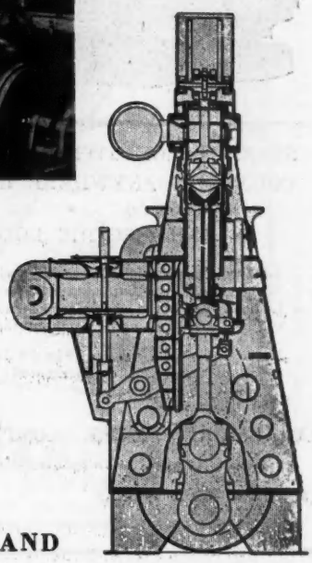
DOXFORD

diaphragm engine

Crank Case Isolation against corrosion.
Lower Piston Oil or Water Cooled as desired.

The unique reputation for long service and reliability attached to Doxford Oil Engines is now enhanced by improvements of considerable importance.

The main feature of the Doxford Diaphragm Engine is the diaphragm and gland which completely isolates the crank chamber from any possibility of corrosion from carbonised oil coming from the cylinder. With cooling of the lower piston by oil or water, the Doxford Engine leaves nothing to chance in marine engineering. Existing Doxford engines can be adapted to the Diaphragm System at moderate cost.



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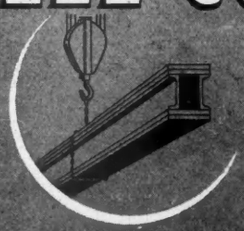

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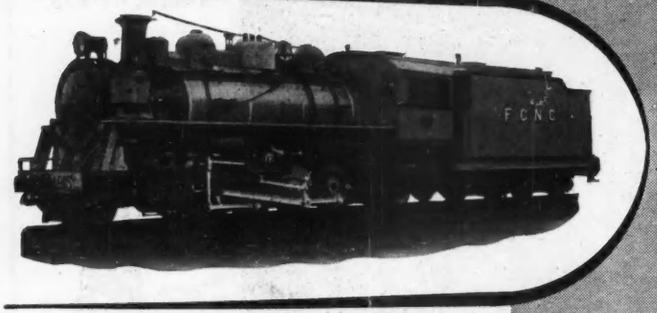

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2-8-2 type mixed traffic locomotives with bogie tenders built to the order of the Antofagasta (Chile) and Bolivia Railway Company and to the inspection of Messrs. Livesey & Henderson by Yorkshire Engine Company Limited.

Metre Gauge; 2 Cylinders 19 in. by 24 in. stroke; pressure 160 lb. per square inch; superheated; tractive effort 26,780 lb. at 85% boiler pressure.

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Builders of Steam and Diesel-Electric Locomotives

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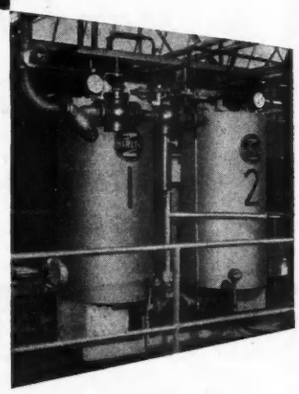
AIR speeds and improves the drying out of refrigerator compressors

Sealed containers of all kinds require moisture exclusion. At the Nash-Kelvinator Works, Crewe, a standard Birlec Lectrodryer is used to improve the drying out of refrigerator compressor units, to prevent icing up during operation. This dryer is a "dual-adsorber", that is, whilst one cylinder is drying the other is being "reactivated" for fresh duty. Working on eight hour cycles, continuous drying is provided; as activated alumina—the drying agent—is, for all practical purposes, indestructible, lifelong service will be obtained from this plant.



The cut-out slip will bring you more details of Lectrodryers.

Dryers are also used in other sections of the electrical industry; copper tubing for condensers is blown out with dry air, dry argon is used for lamp and valve filling, complete work and storage rooms are controlled at a low, safe humidity.

Please send me Lectrodryer details, particularly Pub. 82.
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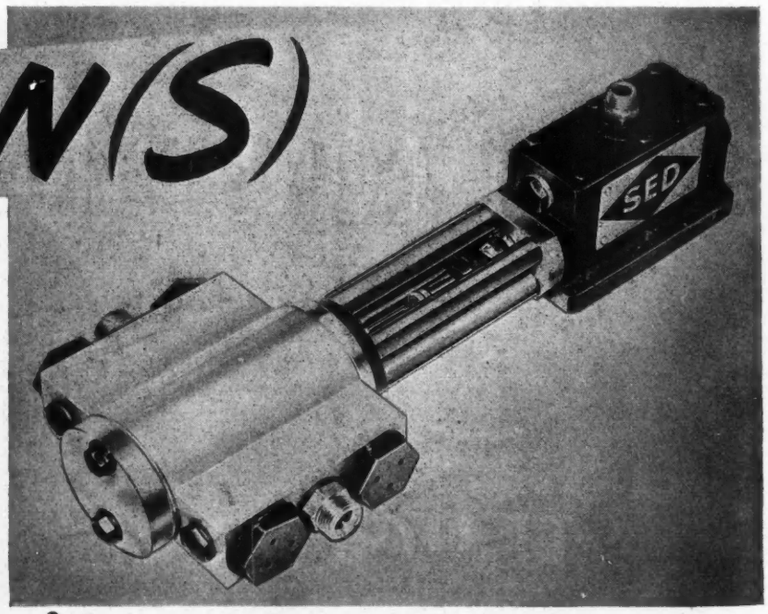

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- ★ Self-contained valves.
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- ★ Pumps liquids up to 200 deg. F.

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Delivery	45 gals. P.H.	120 gals. P.H.
Del. Pressure	30 lbs. P.S.I.	5 lbs. P.S.I.

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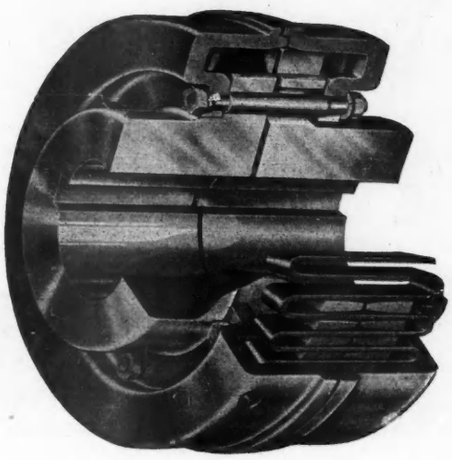

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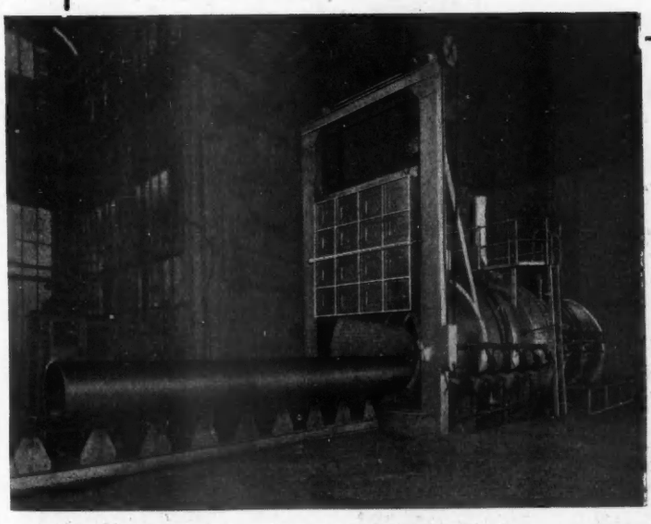

Illustrations show a furnace 6' 9" diameter in the door opening, 7' 6" diameter in furnace with over-all length of 28' 3" from door face to back wall.

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★ Length of heated portion of furnace can be adjusted to suit the tube being heated.

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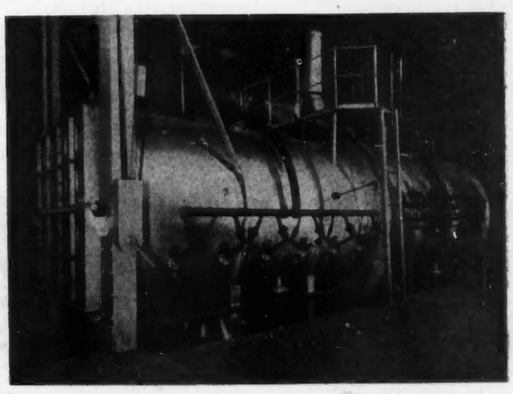

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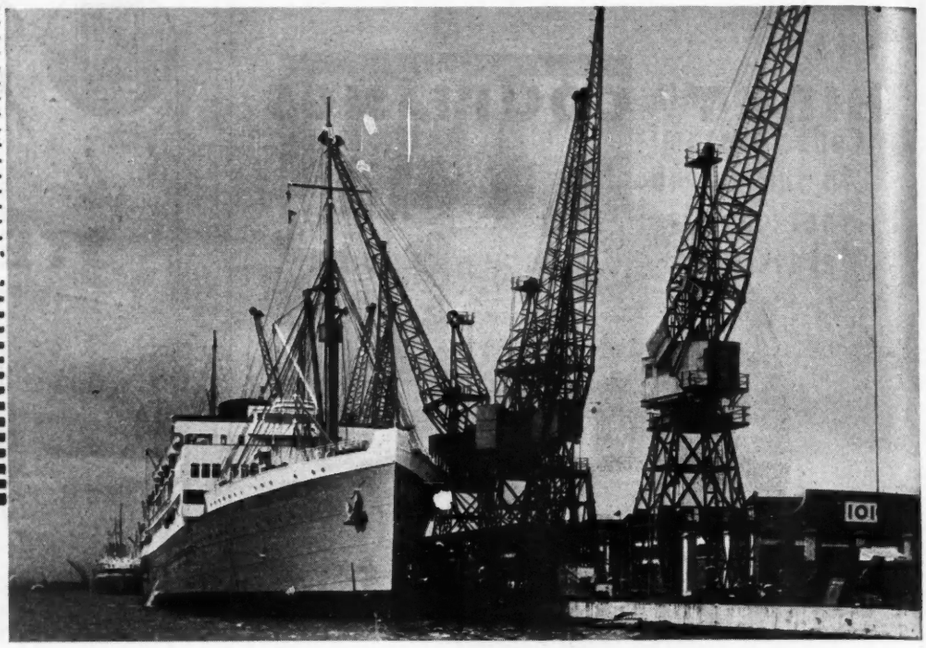

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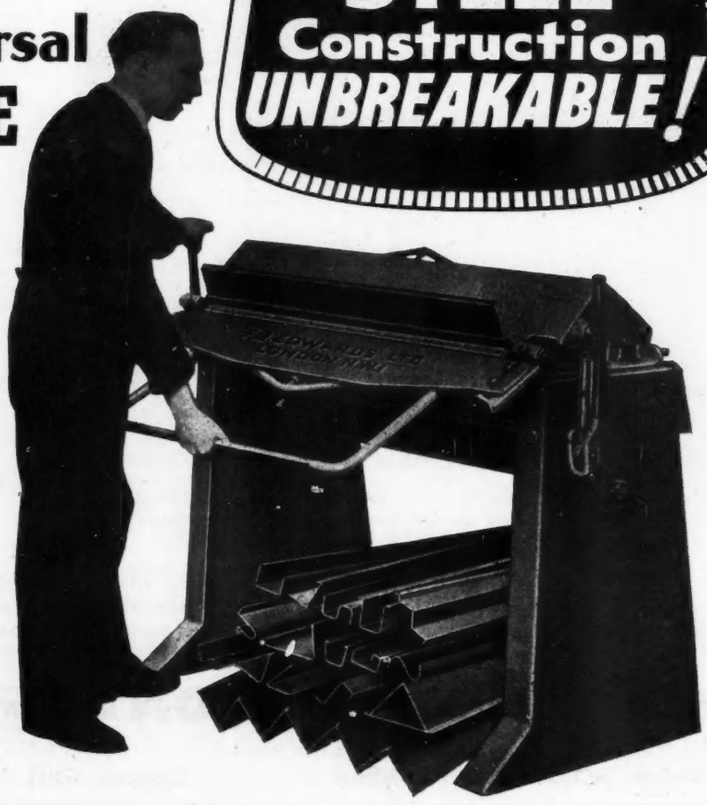

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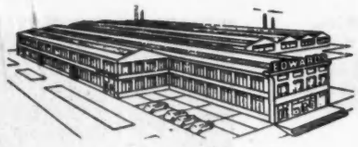

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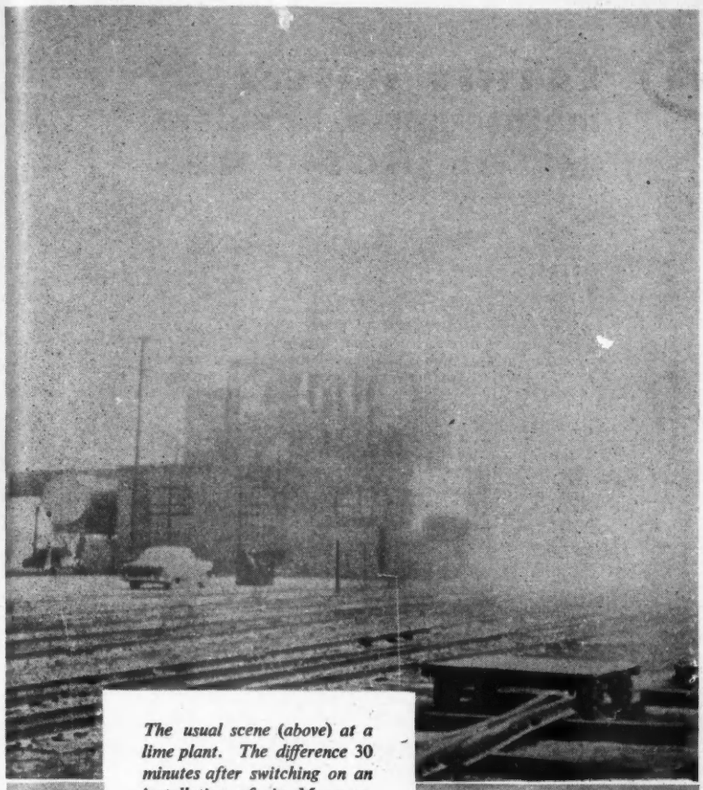

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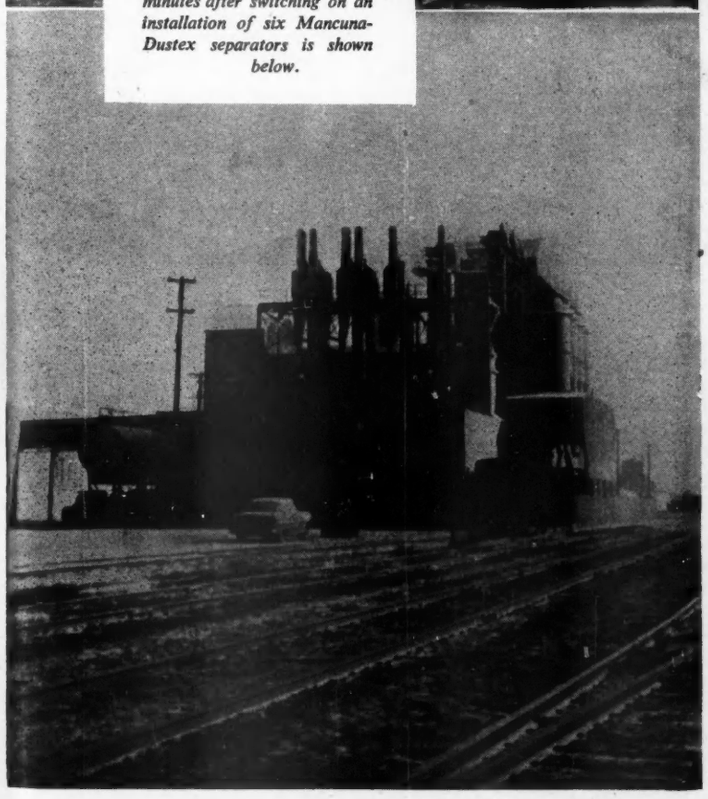

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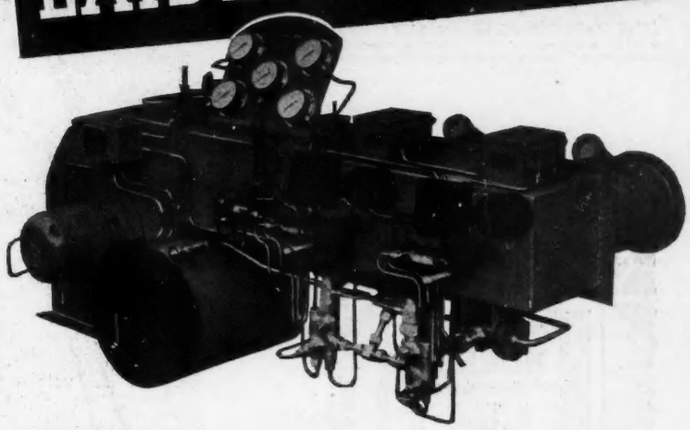

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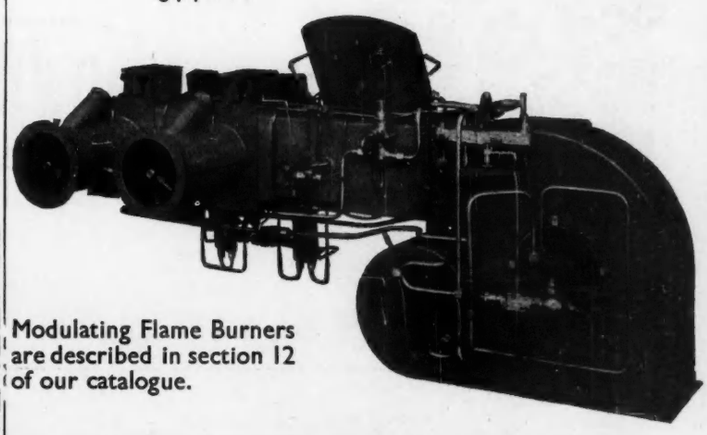

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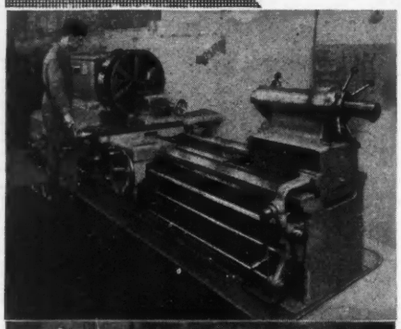

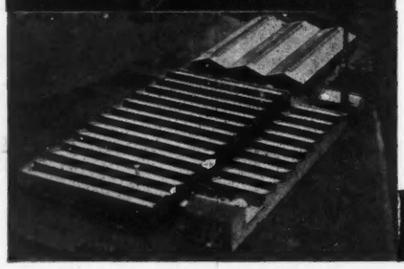

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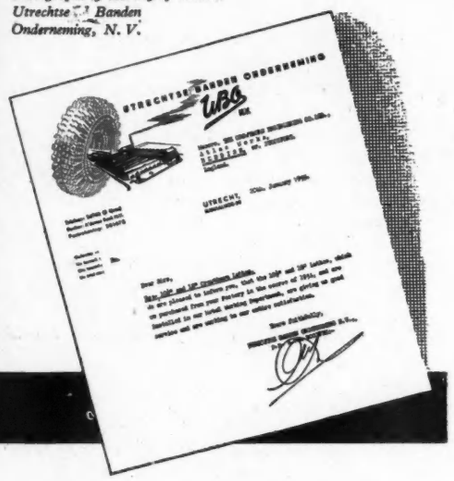

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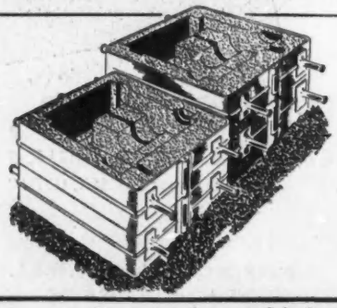

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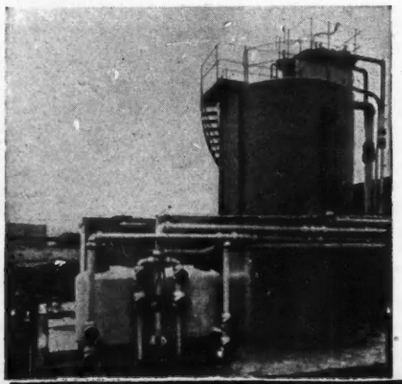

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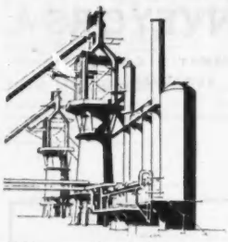

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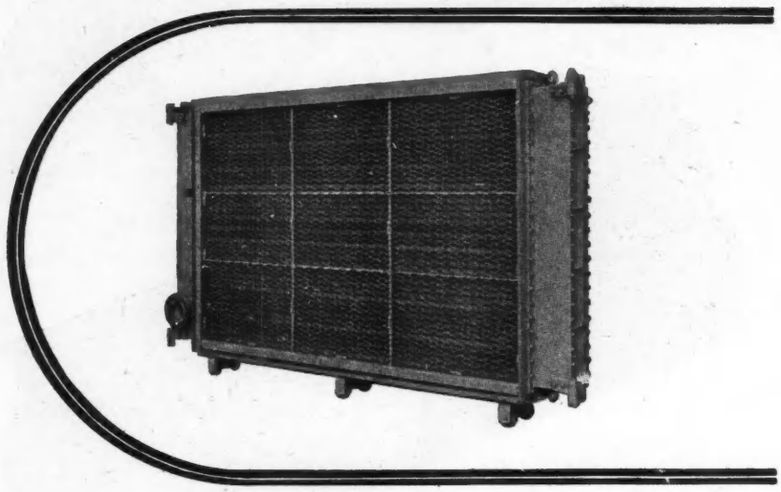

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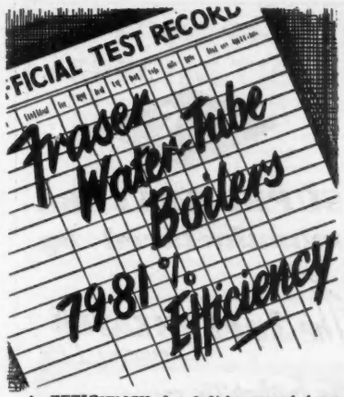

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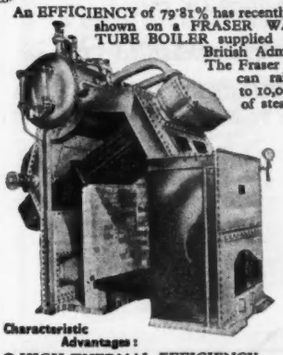

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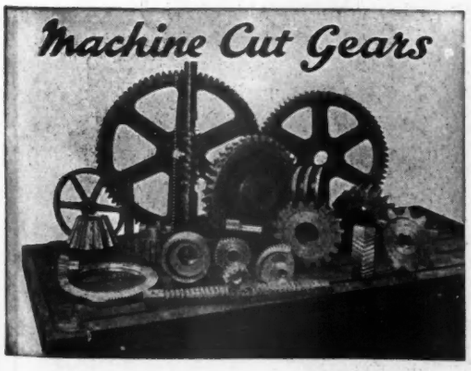

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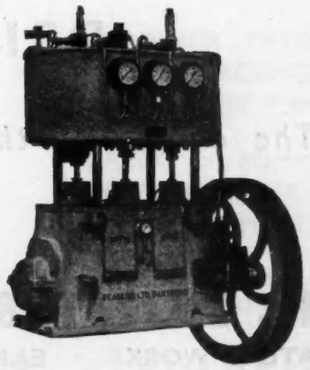

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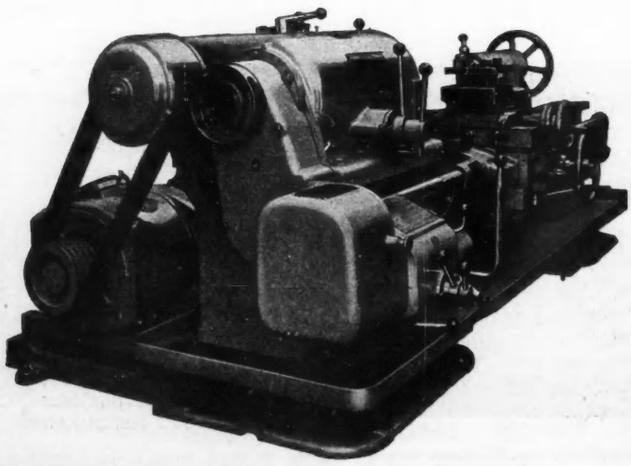

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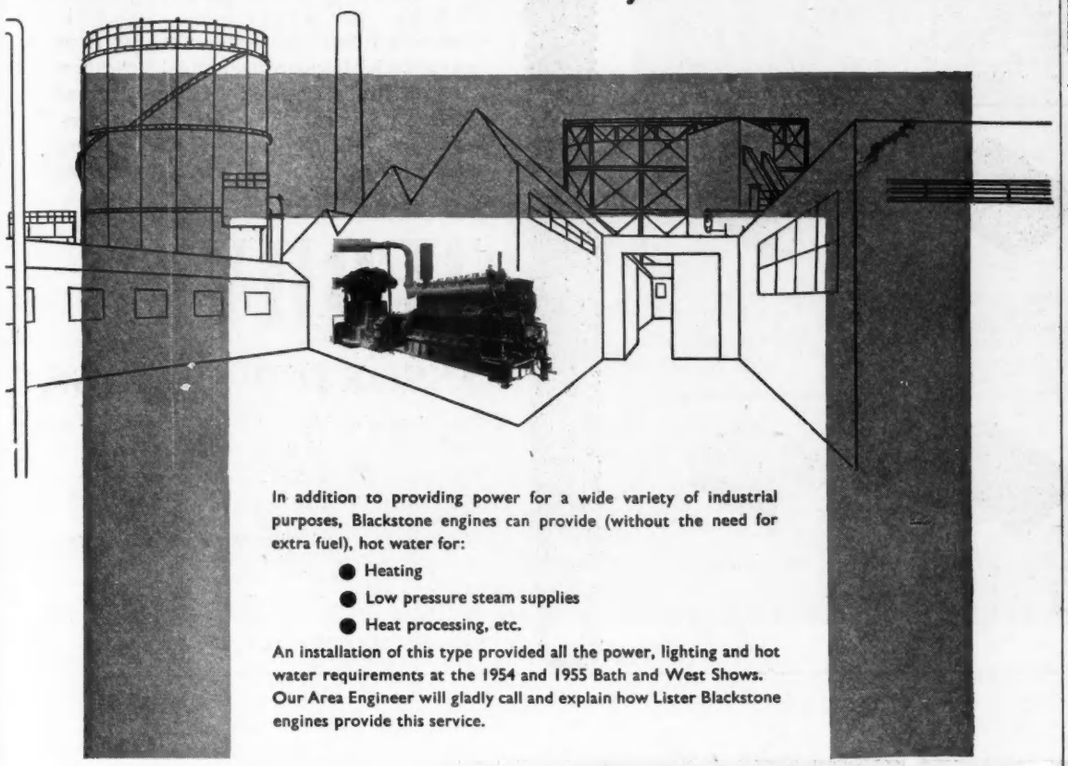

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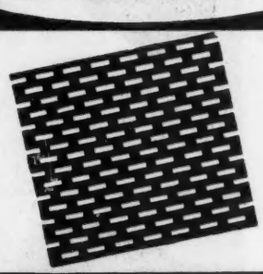

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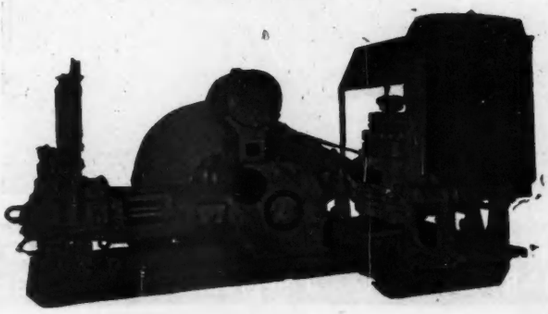

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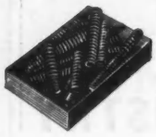

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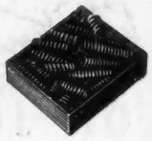

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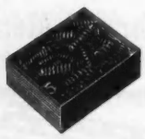

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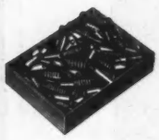

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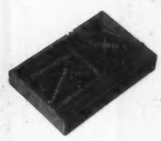

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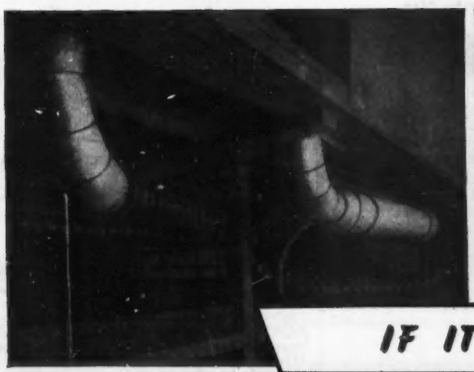

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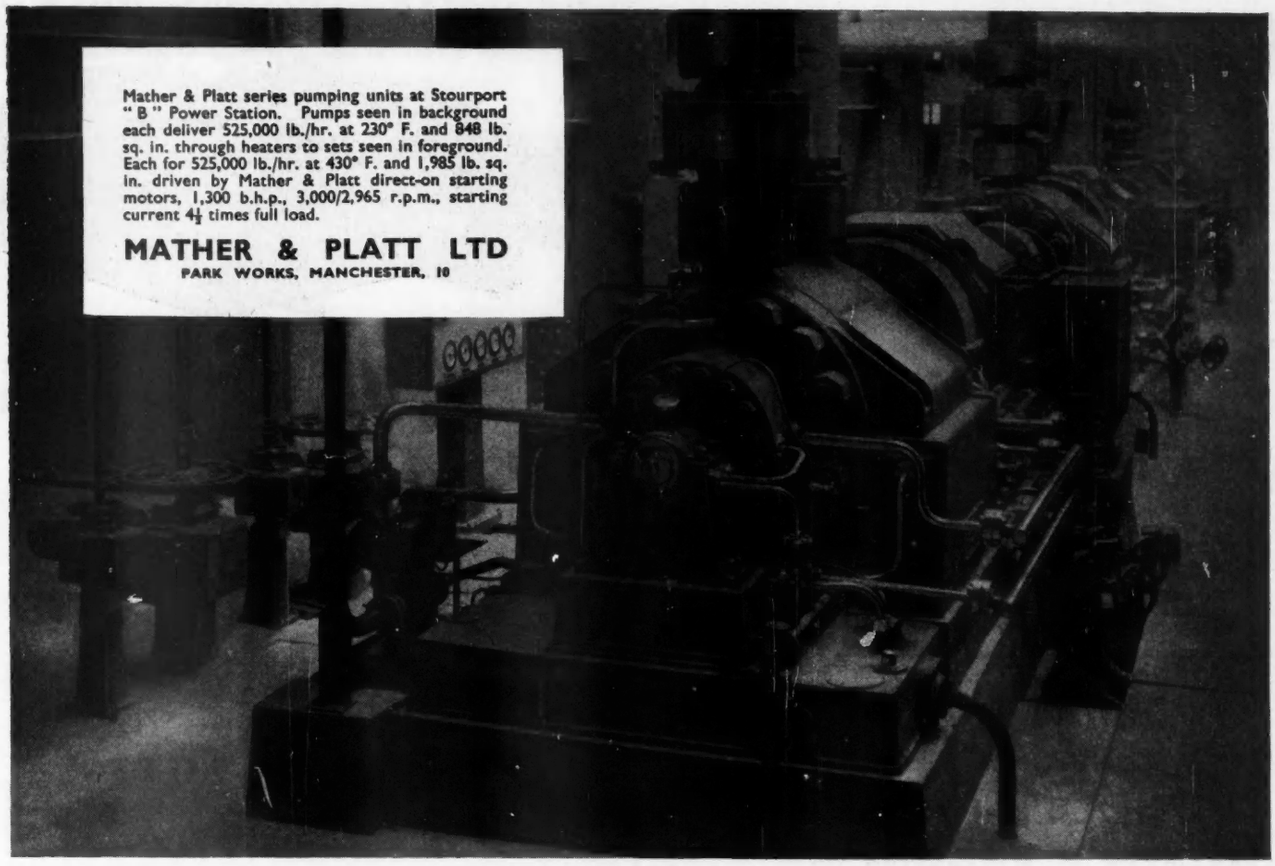

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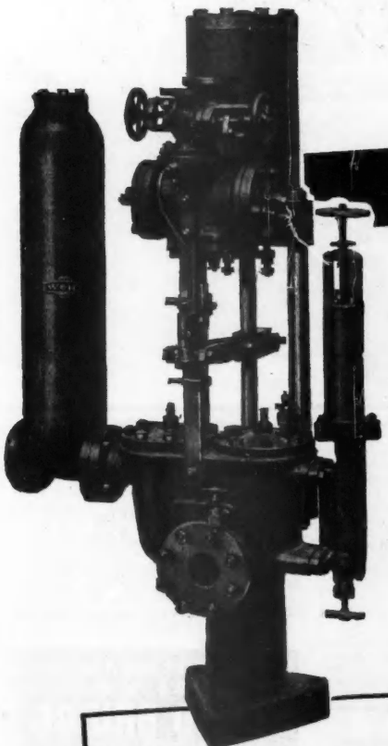

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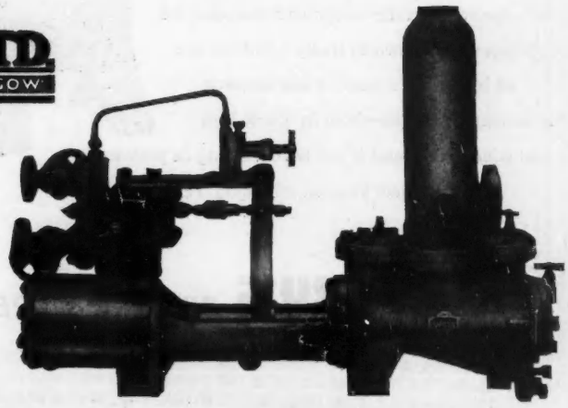

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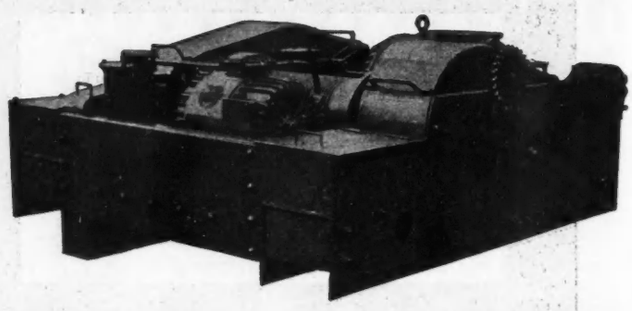

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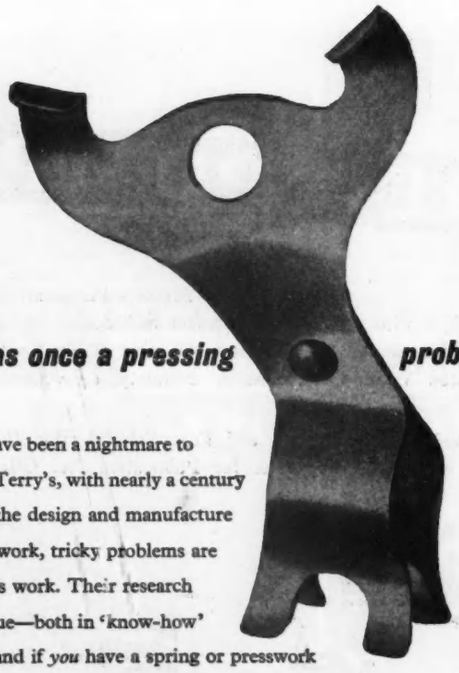

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B	103	1,690	Sp. G. x 2·5	7½	710	5 0	1,524	4 0	1,218
00	263	4,310	Sp. G. x 4	10	485	8 0	2,436	4 0	1,218
1	1,140	18,700	Sp. G. x 24	40	485	13 6	4,114	7 6	2,286
3A	4,562	74,750	Sp. G. x 100	100	485	15 0	4,572	8 0	2,436
9	11,443	187,500	Sp. G. x 225	200	485	33 0	10,100	9 6	2,895
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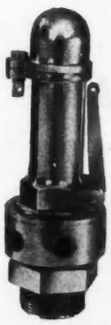

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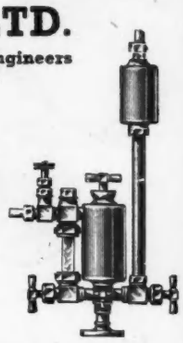

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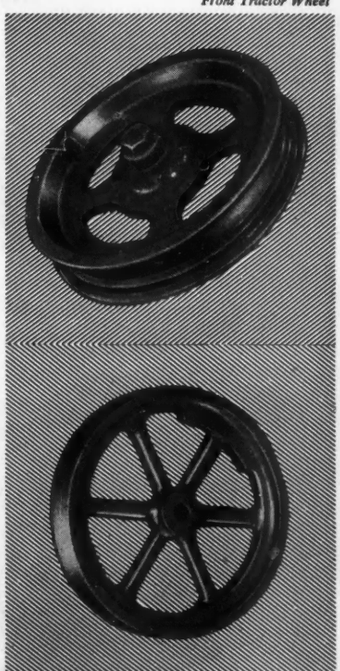

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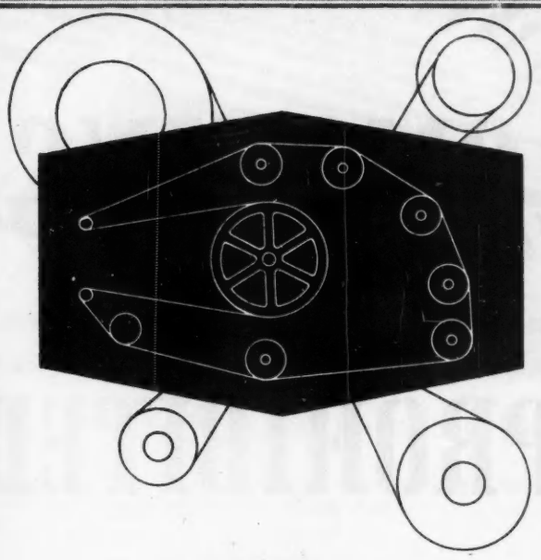

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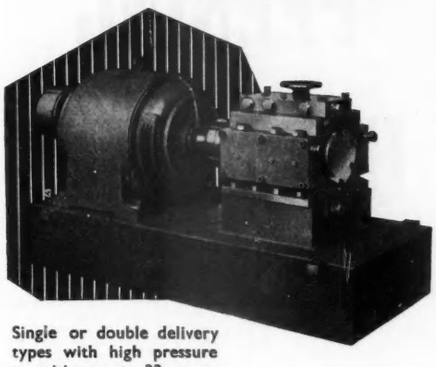

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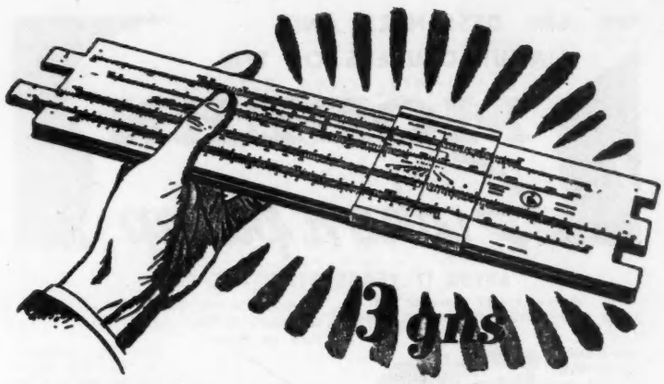

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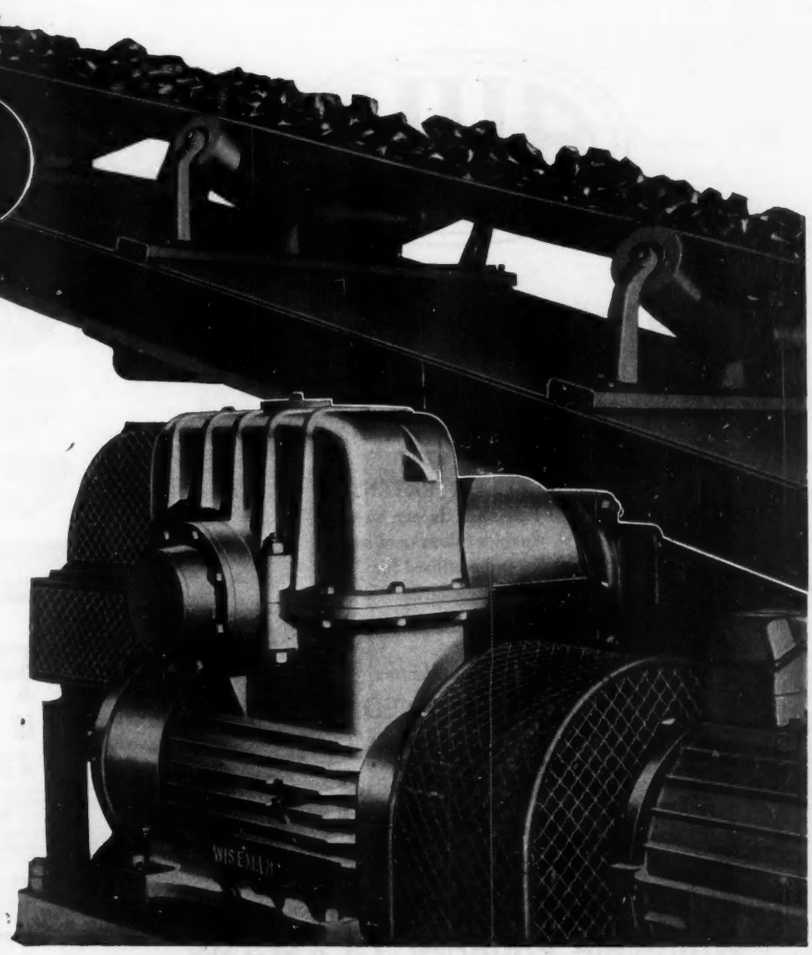

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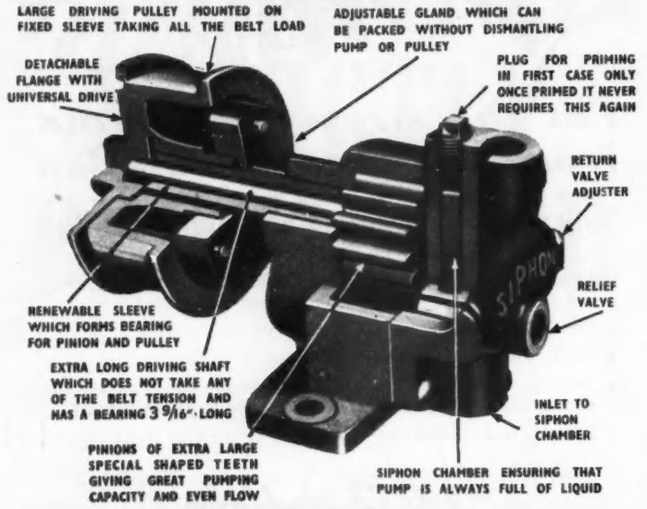
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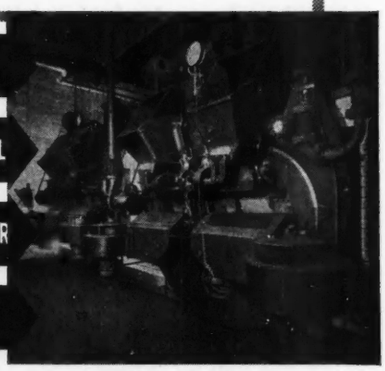

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Evenly distributes fuel, keeps air spaces clinker-free by Self-Cleaning Fire Bars, ensuring complete combustion. Write for details now.

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Classified Advertisements continued from Page 3

Applications are invited for the post of **PROGRESS CONTROLLER** in the TURBINE DIVISION OF BRUSH ELECTRICAL ENGINEERING CO., LTD., LOUGHBOROUGH, LEICS. This is an excellent opportunity for a man having a flair for organisation and a talent for getting things done. First class prospects of advancement to those with drive and initiative. The successful applicant will be responsible to the Production Controller and will control all aspects of progress in the Division. Applicants should have previous production or progress control experience in a modern works. Conditions of service include generous non-contributory superannuation scheme coupled with excellent welfare, sports and social amenities. Please reply to the CHIEF PERSONNEL OFFICER. J 665

SENIOR MECHANICAL ENGINEERING DRAUGHTSMEN required for interesting work on large chemical plant installations. Experience in this type of work is desirable but not essential, applicants with general mechanical engineering experience will be favourably considered. The posts offer excellent opportunities with generous salaries commensurate with experience and ability. Offices situated in the N.W.1 London area. Five-day week and superannuation scheme.—Applications, which will be treated in confidence, should give previous experience and qualifications and be addressed to the CHIEF DRAUGHTSMAN, LAPORTE CHEMICALS LIMITED, CLIFTON HOUSE, EUSTON ROAD, LONDON, N.W.1. G 576

Engineering Design Office working on Development of Excavators and other Civil Contractors' plant offers interesting opportunity for **DESIGNER/DRAUGHTSMAN** with Mechanical and Constructional experience. Write or 'phone PERSONNEL MANAGER, BLAW-KNOX LIMITED, WATFORD. (Telephone: Watford 9291.) J 622

GRADUATES IN MECHANICAL AND CHEMICAL ENGINEERING required for progressive positions in the Research, Design and Production Divisions of THE POWER-GAS CORPORATION LIMITED. Training given to men without previous industrial experience.—Apply to STAFF PERSONNEL MANAGER, PARKFIELD WORKS, STOCKTON-ON-TEES. G 549

BRITISH PETROLEUM COMPANY LIMITED, has immediate vacancies for **CHEMISTS, CHEMICAL ENGINEERS AND MECHANICAL ENGINEERS** for work in their United Kingdom Refineries and at their Research Station at Sunbury-on-Thames. Applications are invited from men with first or second class honours degrees or equivalent qualifications and who have fulfilled National Service obligations. Previous industrial experience desirable, but not essential. Age, preferably not above 33. Salaries within the range £650 to £1300, according to qualifications and experience. Excellent working conditions. Non-contributory Pension Scheme.—Write, giving full details QUOTING H.3297 to BOX 7913, c/o, 191, GRESHAM HOUSE, E.C.2. G 565

ELECTRICAL ENGINEER.

COURTAULDS LIMITED require an additional Electrical Engineer for their Electrical Engineering Headquarters in Coventry.

The work will be with a section covering a wide range of activities from telecommunications to power consumption and commissioning tests on all types of industrial machinery and switchgear.

Applicants should have a University degree or H.N.C. in Electrical Engineering. An apprenticeship or some previous works experience will be an advantage.

Candidates should write for a detailed form of application to the DIRECTOR OF PERSONNEL, COURTAULDS LIMITED, 16, ST. MARTINS-LE-GRAND, LONDON, E.C.1, quoting reference number B.32. J 598

SENIOR AND JUNIOR MECHANICAL AND GENERAL DRAUGHTSMEN

required for

IRON & STEELWORKS ORGANISATION ON NORTH-EAST COAST

Heavy or medium engineering experience desirable but not essential. Vacancies exist both in main and works drawing offices, and can prove progressive to those showing aptitude for advancement. Technical knowledge preferably to H.N.C. standard or higher.

Hours of work are nominally 38 per week with payment for overtime and a Contributory Superannuation Scheme is in operation.

Temporary flat accommodation is available at a moderate rental to successful early applicants, and assistance may be given in respect of removal expenses.

Apply stating age, experience, standard of technical knowledge and salary expected to BOX J 708, Offices of ENGINEERING.

MECHANICAL DRAUGHTSMAN required in London Office of Consulting Engineers for layout of generating plant in hydro-electric power stations. Previous experience in this class of work not essential but starting salary according to qualifications with good prospects for advancement. Apply KENNEDY & DONKIN, 12, CAXTON STREET, S.W.1, quoting reference HH. J 617

CHEMICAL PLANT DESIGNER/DRAUGHTSMEN AND COMPETENT DETAILERS required by ASHMORE, BENSON, PEASE & CO., STOCKTON-ON-TEES. Must be experienced in the layout and detailing of Chemical Plants, pipe flow diagrams, pressure vessel design, etc.

Maximum assistance given in obtaining accommodation. Pension scheme, Technical Library and sports facilities available.

Apply stating age, experience, etc., quoting Ref. C. to STAFF PERSONNEL OFFICER. G 568

SENIOR ELECTRICAL ENGINEER

required to form and take charge of an Electrical Test and Development Section at Brough. The required qualifications comprise at least H.N.C. or its equivalent and comprehensive experience on aircraft electrical systems and components.

Replies giving full particulars and quoting Reference: 121255 to:

DESIGN SUPERINTENDENT,
BLACKBURN & GENERAL AIRCRAFT LTD.,
BROUGH, E. YORKS.

J 683

THE BRITISH THOMSON-HOUSTON COMPANY require a **YOUNG ENGINEER** to join a group engaged on the development of glass-metal seals and glassworking processes in their Research Laboratory at Rugby. Candidates should have a degree in Mechanical or Electrical Engineering or in Glass Technology. Experience in any of the following fields would be an advantage: Glass engineering for lamps, valves or semi-conductor devices, mechanical design, stress analysis, applied mathematics, or statistical methods.

Applicants are invited to write to the DIRECTOR OF RESEARCH, BRITISH THOMSON-HOUSTON CO., LTD., RUGBY, giving details of their age, qualifications and experience, quoting reference SM. J 563

Firm of engineers, designers and manufacturers of a specialised range of precision and scientific equipment, naval, military and civil, invites applications for the following vacancies in their Drawing Offices in Glasgow:—

DESIGNER, TWO SENIOR DRAUGHTSMEN AND TWO JUNIORS, WITH SOME EXPERIENCE.

The Senior posts are for men of marked ability and initiative. The Junior positions ensure experience and opportunity to keen young men desirous of extending their knowledge and advancing to more responsible work. Salaries according to qualifications.

Applications should state age and give details of education and experience and should be addressed to the SECRETARY, BARR & STROUD, LIMITED, ANNIESLAND, GLASGOW, W.3, under reference 921/T-15. J 603

Well-established Australian Company wishes contact **MAKERS OF GANTRY CRANES** desiring representation in the Commonwealth.—Reply in the first instance to BOX J 727, Offices of ENGINEERING.

Classified Advertisements continued on Page 102

Do not disturb

Can two hands do the work of four — or six — or more? Does increased production necessarily require more man-power?
Can life be made more attractive and easy for my present operators?
These are questions often asked by harassed production executives in practically every industry, and the lucky ones find the answers they want in Enots several booklets explaining in fullest detail the advantages of controlled air power in the factory.
Automate with Enots and British Bellows Pneumatic Equipment NOW! Our technical representatives are ready to advise you on your particular problems — and without the slightest obligation of course.

Two short films "Production Miracles" and "Operation Push Button" produced by the Bellows Corporation of Akron, Ohio, U.S.A., and illustrating the application of pneumatic devices as aids to increased production and efficiency, are available for exhibition on application to Benton and Stone Limited.

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WELDING ENGINEER to approve construction details of pressure vessels and fabrications, prepare specifications for welding procedure and liaise with works and testing laboratory. Must be Drawing Office trained with special experience of design and production in welding construction. The appointment is permanent and pensionable housing assistance offered.
Applications to:—
PERSONNEL MANAGER,
MARSHALL SONS AND COMPANY LTD.,
BRITANNIA WORKS,
GAINSBOROUGH. J 602

West End London Consulting Engineers require now **SEVERAL SENIOR AND JUNIOR ENGINEER DRAUGHTSMEN** to prepare designs, contract drawings, specifications, etc., for heating, ventilating, boiler plant and allied mechanical services. Interesting work for factories, office blocks, hospitals, colleges, schools, etc. Opportunity for experienced men with initiative. Five-day week. One week's spring holiday in addition to usual summer two weeks. Bonus and optional superannuation scheme.—Write stating age, experience, qualifications and salary required. BOX G 538, Offices of ENGINEERING.

MECHANICAL ENGINEERS

are required for work in connection with guided missiles. Previous design experience in mechanical handling or conveyor systems would be useful, and it is desirable that applicants should possess an H.N.C. or equivalent.

Pleasant working conditions and amenities are provided, an attractive superannuation scheme is in operation, the work is of a permanent character in a new and expanding field, and salaries are good.

Replies will be treated in the strictest confidence, and should be addressed to

the Staff Employment Officer,
SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT, LTD.,
ARMAMENT DIVISION,
WHITLEY, COVENTRY. J 656

SENIOR PLANNING ENGINEER required with previous experience in mass production of small engines. Good salary with excellent prospects. Pension Scheme.—Apply to CHIEF PERSONNEL OFFICER, PETTERS LIMITED, CAUSEWAY WORKS, STAINES. G 617

MECHANICAL DRAUGHTSMAN required by the Bank of England Printing Works, now situated in E.C.1, but moving shortly to new factory near Loughton, Essex. The work of the technical team he would join involves the design and development of special printing machinery for new mass production processes. Previous experience with printing machinery or paper converting machinery would be an advantage. The appointment will be permanent and pensionable under a non-contributory scheme and facilities for house purchase would be made available if required. Starting salary up to £800 per annum. Candidates should be aged 21-30 and British by birth. Write, giving age and fullest details of education, qualifications, training and experience to the STAFF MANAGER, ST. LUKE'S PRINTING WORKS, OLD STREET, E.C.1. J 650

TWO TIME STUDY ENGINEERS

are required by
a medium-sized light engineering company in North London. Experienced in effort rating and determination of work values, preferably by the Bedeaux Method. Good salary according to qualifications. Pension scheme. Assistance with house purchase and removal expenses. Good working conditions.—Apply in writing, giving full details of previous experience and qualifications, in strict confidence to the WORKS DIRECTOR, SPARKLETS, LTD., QUEEN STREET, N.17. J 707

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DRAUGHTSMEN to design in aluminium for sales development. Must possess Higher National Certificate in Mechanical Engineering. Location Banbury. Good working conditions and pleasant surroundings. Attractive starting salaries offered up to £800 p.a. with prospects of promotion from drawing board. Pension plan in operation. Send brief details of qualifications and experience to NORTHERN ALUMINIUM CO. LTD., BUSH HOUSE, ALDWYCH, LONDON, W.C.2. G 562

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It's a long-sighted policy to fit L. & C. diesel piston rings and range yourself on the side of power economies. For our rings *do* prevent power slipping over the border. Once fitted, they ride the cylinders smoothly—their even wall pressure rounding up every pound of power for its proper purpose. Can we tell you why L. & C. rings are different? Yes—send for a copy of our catalogue, which fully explains their uses and applications.

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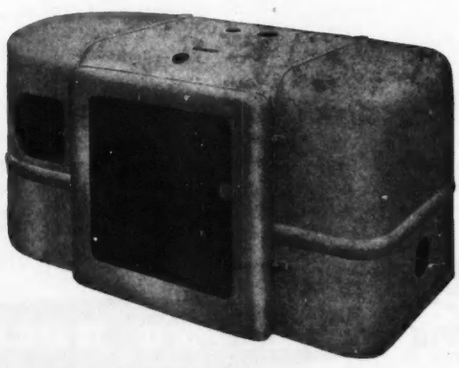

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PETER BROTHERHOOD, LTD., Peterborough, require
DRAUGHTSMEN (SENIOR AND JUNIOR) preferably with experience in design of compressors, turbines and steam engines. Permanent positions, five-day week, staff pension scheme.—Write, giving full details age, experience and salary required. Z 426

DRAUGHTSMEN, with O.N.C. or H.N.C. in Mechanical Engineering, are urgently required in various Drawing Offices at Fort Dunlop. There are exceptionally good opportunities for Draughtsmen interested in plant layout (including services); special purpose machine design; and design of tyre moulds. Promotion comes swiftly to keen and efficient men. There is a good pension scheme.—Please write, giving age, experience and salary required, to PERSONNEL MANAGER, DUNLOP RUBBER CO., LTD., FORT DUNLOP, ERDINGTON, BIRMINGHAM, 24. J 536

CHEMICAL ENGINEERING COMPANY in Westminster district has a vacancy for a **TECHNICAL AND SALES ENGINEER.** Qualifications are: age about 25-30. B.Sc., standard good knowledge physics, heat exchange essential and chemistry desirable. Understanding of general office procedure an advantage. The position offers an excellent opportunity for a man having these qualifications, coupled with a keen business outlook Write stating fullest possible particulars, including age, qualifications and salary required to BOX J 682, Offices of ENGINEERING.

QUANTITY SURVEYOR required by Consulting Engineers in Birmingham. Staff pension scheme. Please reply in confidence giving qualifications, previous experience, age, etc., to BOX No. 295, GLOVERS ADVERTISING LIMITED, 351, OXFORD STREET, LONDON, W.1. G 595

CHIEF VALVE DESIGNER with design and production experience of valves up to 36in. diameter bore. Excellent prospects for engineer with originality and initiative. Salary £1200 upwards. House available.—ROBERT CORT & SON, LTD., READING BRIDGE, READING. J 643

LEVER BROTHERS, PORT SUNLIGHT, LIMITED,
require
ENGINEERING ASSISTANTS
for work on a power station project. The work involves the design and construction of a power station, complete with oil-fired boiler plant, back-pressure turbines, a large water treatment plant, and an extensive steam distribution system. Applicants should hold a H.N.C. or equivalent and have had experience of work connected with the design and layout of power stations. The position is classed as Supervisory grade of Management. Contributory Pension Scheme. Five-day week, day work. On completion of the project the Company will be recruiting staff for operation and maintenance of the new station, and Engineering Assistants employed on the project will be considered in this connection.—Applications giving full details of qualifications and experience should be made in writing and addressed to the PERSONNEL MANAGER, LEVER BROTHERS, PORT SUNLIGHT, LIMITED, PORT SUNLIGHT, CHESHIRE. J 703

soot blowing

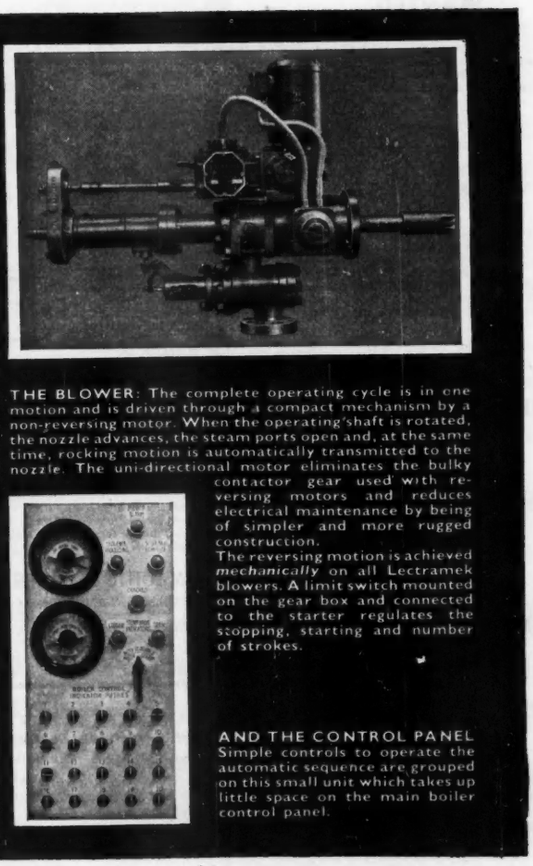
is a push-BUTTON job

with the NEW CLYDE system

UNIFIED LECTRAMEK CONTROL SYSTEM

most efficient yet devised.

Considerable savings in initial cost and valuable boiler room space have been achieved by this new system of electrical control which works in conjunction with the Clyde Lectramek Soot Blower * - the original blower employing a uni-directional motor. Control is exercised from a small panel which indicates all essential information to the operator.



THE BLOWER: The complete operating cycle is in one motion and is driven through a compact mechanism by a non-reversing motor. When the operating shaft is rotated, the nozzle advances, the steam ports open and, at the same time, rocking motion is automatically transmitted to the nozzle. The uni-directional motor eliminates the bulky contactor gear used with reversing motors and reduces electrical maintenance by being of simpler and more rugged construction.

The reversing motion is achieved *mechanically* on all Lectramek blowers. A limit switch mounted on the gear box and connected to the starter regulates the stopping, starting and number of strokes.

AND THE CONTROL PANEL Simple controls to operate the automatic sequence are grouped on this small unit which takes up little space on the main boiler control panel.

CLYDE SOOT BLOWER EQUIPMENT

Further information is given in our publication No. CBL. 1954 which will be supplied on application.

CLYDE

CLYDE BLOWERS LTD · CLYDEBANK · SCOTLAND · Tel: Clydebank 1576/7

* *Over 5,000 blowers of this type in use all over the world.*

PRODUCTION ENGINEERS are required by THE MORGAN CRUCIBLE CO., LTD. One vacancy is for a Deputy to the Chief Production Engineer. Applicants aged 24-30 should hold a degree or H.N.C. in Mechanical or Production Engineering. They should have some workshop experience followed by a minimum of 2 years industrial experience of production. Knowledge of shop layouts, work study and mechanical handling an advantage. Applicants should be good mixers at all levels, prepared to work in a team and capable of writing accurate reports. The posts are permanent and pensionable with good canteen and general welfare facilities.—Please write, in confidence, all relevant details including salary required to the STAFF MANAGER, BATTERSEA CHURCH ROAD, S.W.11. J 711

MECHANICAL ENGINEER. Vacancy exists in Development Section of large civil engineering contractors' London office. Applicants should be about 25 years old with shop and d.o. experience. Unusual scope for advancement. Salary about £700 p.a. plus bonus, depending on suitability. Pension Scheme operates.—BOX J 647, Offices of ENGINEERING.

Seventy-five pounds per month and upwards according to experience offered for **EXPERIENCED DESIGNER** in R.C. as applied to commercial buildings Pension scheme and a permanent position with an old-established company in their London Head Office. Five-day week. A vacancy also exists for Designer/Draughtsman working under Senior Designer with salary from £50 p.m.—Reply BOX G 587, Offices of ENGINEERING.

GRADUATE.

An old-established and rapidly expanding company manufacturing internationally known products in the medium electrical and mechanical engineering field requires young Graduate Engineer.

Practical background covering development o electric motors and control gear essential. Initially, he will take charge of a small development team concerned with Aerodynamic application of this equipment. This position holds excellent prospects to managerial level and carries an attractive commencing salary and bonus.

The factory is situated near an East Coast market town in rural surroundings convenient to London. Unfurnished accommodation available.

Write with full details to PERSONNEL MANAGER, BOX J 690, Offices of ENGINEERING.

DOWTY EQUIPMENT LIMITED require **HYDRAULIC PUMP DESIGNER.** Should have aircraft experience and preferably University Degree. A.F.R.Ae.S. qualifications an advantage. Executive status for successful applicant.—Write to the PERSONNEL MANAGER, ARLE COURT, CHELTENHAM SPA, GLOS. J 672

DRAUGHTSMEN (SENIOR AND JUNIOR) required for work in connection with the following branches of Coke Oven and Gasworks plants.

(*a*) Mechanical and By-Product Plant.
(*b*) Pipework.
(*c*) Steelwork for Buildings and Conveyors.

Applicants should be competent men able to work with the minimum of supervision. Technical qualifications to O.N.C. or beyond. Good remuneration and prospects for capable men. Pension scheme. Five-day week; Canteen Facilities.—State age and experience to the PERSONNEL OFFICER (D.O.), WOODALL-DUCKHAM CONSTRUCTION COMPANY LTD., WOODALL-DUCKHAM HOUSE, 63-77, BROMPTON ROAD, LONDON, S.W.3. G 550

BOOTS PURE DRUG CO., LTD., have a vacancy in their Engineering Department drawing office at Beeston for a **MECHANICAL DRAUGHTSMAN** experienced in the layout and detailing of chemical and/or pharmaceutical plant. The Company normally works a five-day week and the position would be both permanent and pensionable. The commencing salary for a suitably qualified candidate would be in the region of £700. Applications giving details of both practical training and theoretical qualifications, should be addressed to the PERSONNEL MANAGER, STATION STREET, NOTTINGHAM. J 678

DRAUGHTSMEN, SENIOR AND JUNIOR, with general engineering experience are required for a large Plate Glass Works. The work includes plant layout, both heavy and light, design of special purpose machines, provision of building and services and the modernisation of existing machinery and plant.

The office is a medium size with about thirty persons, so that each and all get a good variety of jobs. There are opportunities for promotion for those who show an interest and aptitude for production work.

Write giving age, qualifications and experience to the CHIEF ENGINEER, PILKINGTON BROTHERS, LIMITED, ROWLEY HILL WORKS, ST. HELENS, LANCASHIRE. J 697

CIVIL AND STRUCTURAL ENGINEERING DESIGNER AND DRAUGHTSMEN AND STRUCTURAL CHECKERS required for Consultants Offices in Bristol and elsewhere in England and Wales. Must be experienced in one or more of the following:—Structural Steelwork for buildings and material handling plants, reinforced concrete pipework and general building construction.

Five-day week, pension scheme and good salaries and opportunities for promotion by merit.

Reply stating age, experience and qualifications.—BOX J 651, Offices of ENGINEERING.

ASSISTANT ENGINEER required in London Office of Consulting Engineers for contract and engineering work on generating plant for hydro-electric power stations. Previous experience on this class of work not essential but starting salary according to qualifications with good prospects for advancement. Apply KENNEDY & DONKIN, 12, CAXTON STREET, S.W.1, quoting reference HH. J 618

Classified Advertisements continued on Page **104**

MECHANICAL ENGINEERS AND DRAUGHTSMEN required for important and interesting projects in the fields of Automation, Nuclear Engineering and Data Handling. Good salary and conditions. Pension scheme. Five-day week.—Apply with details to MERVYN INSTRUMENTS, ST. JOHN'S, WOKING, SURREY. J 688

ENGINEERING DRAUGHTSMEN (MALE OR FEMALE) required for large Sheet Glass Works. Experience in Works Maintenance, Building or Mechanical Design would be an advantage. The positions are pensionable and progressive.—Applications stating qualifications, age and experience should be addressed to the CHIEF ENGINEER, PILKINGTON BROTHERS, LIMITED, SHEET WORKS, ST. HELENS, LANCASHIRE. J 699

BOILERSHOP MANAGER with good engineering training, experience of high class boilermaking and practical knowledge of class I welding technique. —Applications, giving full particulars of qualifications for the post, to be submitted to the SECRETARY, COCHRAN & CO., ANNAN, LTD., ANNAN, DUMFRIESSHIRE. J 719

MEASUREMENT ENGINEER required for large Civil Engineering contract in N.W. England. Applicant should have had at least 3 years as site engineer with contractors. Experience of certificate preparation would be an advantage. This is a permanent and pensionable appointment with a major Civil Engineering Company.—Write quoting reference B/1 stating full details of experience and salary required to BOX J 705, Offices of ENGINEERING.

DESIGNER required by firm of Process Engineers in South of England for work on pumps and other hydraulic equipment. Position carries high degree of responsibility for the development of complete projects.—Please apply to BOX J 706, Offices of ENGINEERING.

DRAUGHTSMEN required, preferably with some experience in design of any of the following: Machine Tools, Jigs and Fixtures, Press Tools or Dies and Moulds. Good conditions of employment. Starting salary according to qualifications, advancement on merit. Firm has good Superannuation Scheme.—Write stating full technical and practical training and experience, etc., to CHIEF PLANT ENGINEER, THE SINGER MANUFACTURING CO., LTD., CLYDEBANK. J 700

PHYSICIST-GRADUATE in pure or applied science required for laboratory engaged in a wide variety of research and development, some experience in industrial research desirable but not essential. —Applicants should state age and give details of education and experience and should be addressed to the SECRETARY, BARR & STROUD, LTD., ANNIESLAND, GLASGOW, W.3, under reference 927/T-15. J 716

DETAIL DRAUGHTSMAN required, O.N.C. preferred, for interesting electro-mechanical equipment for use on ships. Absorbing work with good prospects of advancement for a man with initiative. State age, qualifications, experience, salary required, and if possible send sample of drawing work with application to MR. E. R. BROOKE, NAVAL DRAWING OFFICE, EVERSHED & VIGNOLES, LIMITED, ACTON LANE WORKS, CHISWICK, LONDON, W.4. J 689

BRITISH PETROLEUM COMPANY LIMITED requires an
INSPECTING ENGINEER—AGED 30-35—familiar with office routines. Degree in Engineering essential and preference will be given to the applicant who is also a member of an Engineering Institution. Should have good knowledge of operation and maintenance of machinery and a sound practical workshop experience. May be required to act as deputy to the Chief Inspecting Engineer during his absence. Salary according to age, qualifications and experience. Non-contributory Pension Scheme. Luncheon Club.—Write giving full details, quoting H.3484, to BOX 8172, c/o 191, GRESHAM HOUSE, E.C.2. G 594

SULZER BROS. (LONDON), LTD., require
SENIOR AND JUNIOR DIESEL ENGINEERS for Rail Traction Department. Sound technical background and qualifications essential. Good salary commensurate with experience.—Write giving full details including present salary to SECRETARY, 31, BEDFORD SQUARE, LONDON, W.C.1. J 701

BRITISH MERCHANT FIRM IN MALAYA with established Engineering Department, holding exclusive agencies for leading British makers of excavators and other mechanical plant also electrical plant, has vacancy for an
ENGINEER on the sales side, age 22-25 and single. Candidate should have either a Degree or Higher National Certificate.
Liberal salary, etc., terms, including free furnished quarters and car allowance. Interview London.—Write with full particulars of education and experience to BOX T.680, c/o STREET'S, 110, OLD BROAD STREET, E.C.2. J 704

ENGINEERS.

Applications are invited from qualified
MECHANICAL ENGINEERS (PREFERABLY A.M.I.MECH.E.) for a number of permanent and pensionable appointments at Fort Dunlop. Industrial experience of plant layout and mechanical handling systems is desirable; knowledge of Work Study techniques an advantage. These positions provide excellent scope for advancement in an expanding Company with world-wide interests.—Please write, giving age, qualifications, experience and salary required to the PERSONNEL MANAGER, DUNLOP RUBBER CO., LTD., FORT DUNLOP, ERDINGTON, BIRMINGHAM, 24. J 709

MECHANICAL ENGINEERING DRAUGHTSMEN required with training in Maintenance, Building and Mechanical problems. A knowledge of machine design would be an advantage. The positions are pensionable and progressive. —Applications stating qualifications, age and previous experience, should be addressed to the WORKS PERSONNEL OFFICER, PILKINGTON BROTHERS, LIMITED, RAVENHEAD WORKS, ST. HELENS, LANCASHIRE. J 698

Large engineering group in the north-east is now establishing a development section with the object of developing new products in the mechanical engineering field, covering prime movers, heat exchangers and ancillary equipment.
Good opportunities are available for **SUITABLY TRAINED ENGINEERS** of degree or H.N.C. standard. Salary depending on qualifications and experience; pension scheme; five-day week.
Apply BOX J717. Offices of ENGINEERING.

CAPACITY AVAILABLE.

HAND & POWER PRESS WORK

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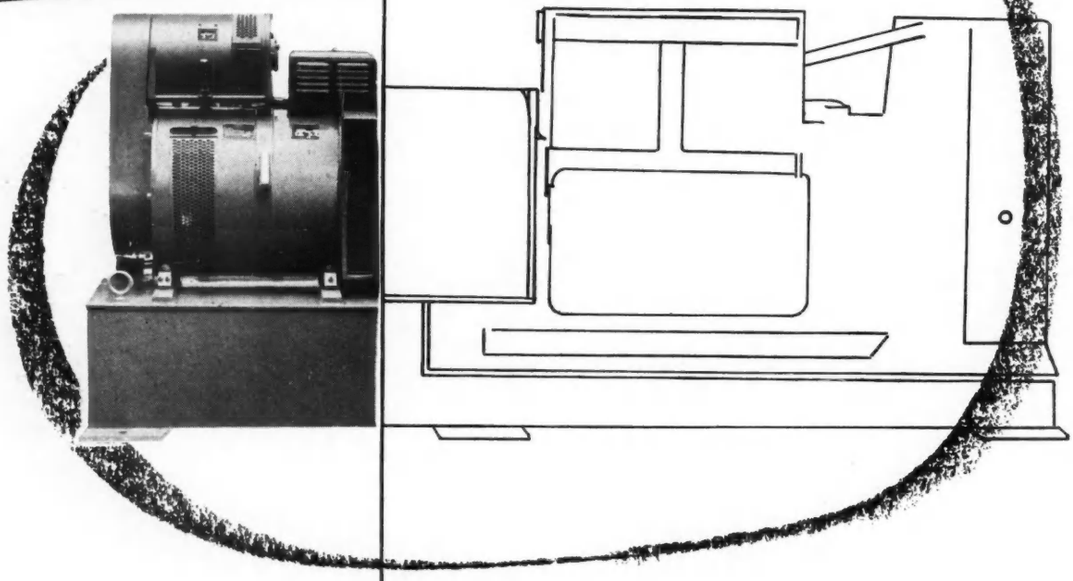

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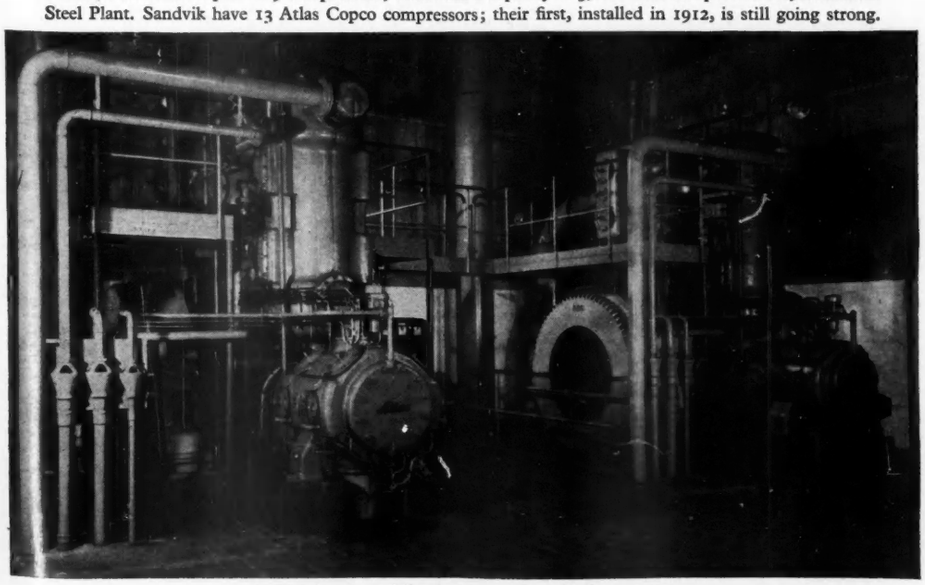

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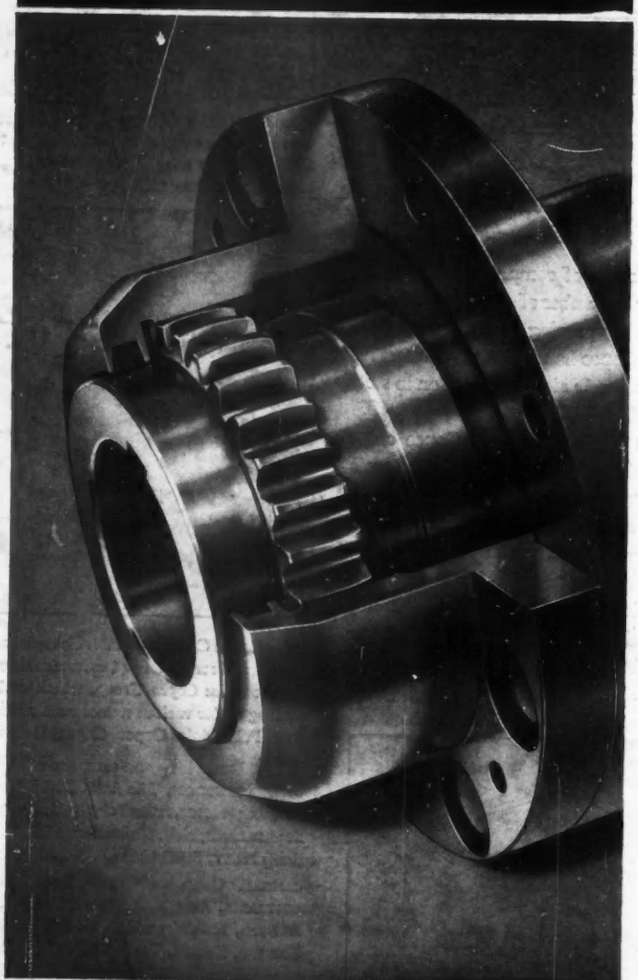

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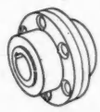

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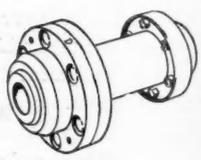

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